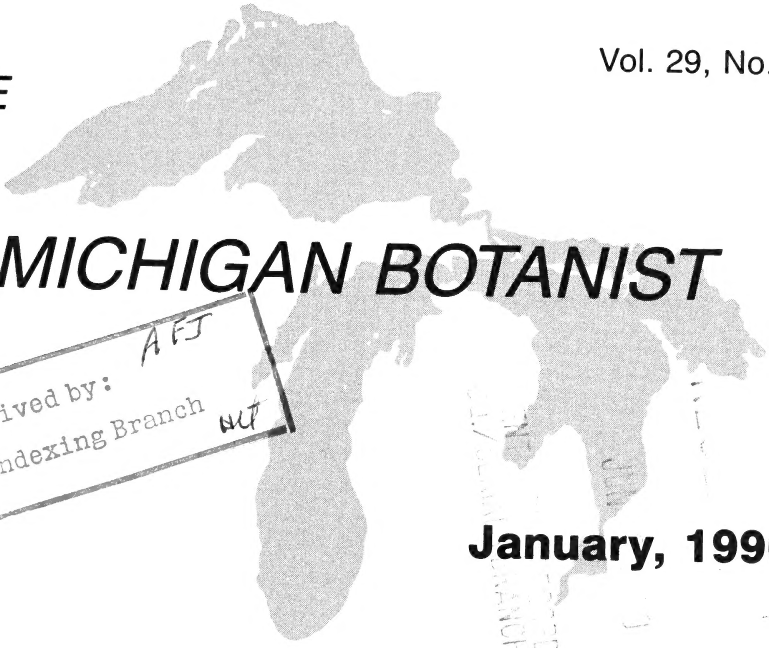

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SCANNING ELECTRON MICROSCOPY OF SEEDS IN THE TAXONOMY OF MICHIGAN JUNCUS

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The surface features of leaves, fruits (especially achenes), and seeds are now generally regarded as significant in the taxonomy of angiosperms. Viewing these surfaces with the scanning electron microscope (SEM) now makes possible a level of resolution not afforded by light microscopy. To our knowledge there have been only four other studies that have used SEM on North American *Juncus*. Three are published (Brooks & Kuhn 1986; Ertter 1986; Catling & Spicer 1988), and one of them is unpublished (Clements 1979).

A review of subgeneric taxonomy of *Juncus* suggests that the establishment of additional differentiating characters is desirable. The present study uses SEM to compare seed characteristics within and among subgenera and to further substantiate the systematic value of these characteristics in the genus using taxa occurring in Michigan.

MATERIALS AND METHODS

Using the three regions recognized by the Michigan Department of Natural Resources (the upper peninsula, and the northern and southern portions of the lower peninsula), two specimens were sampled from each region (see Appendix). If a species did not occur within all three regions, specimens were sampled from bordering states and/or provinces. In the absence of seeds from Michigan or bordering states/provinces, non Great Lakes specimens were sampled. A minimum of three seeds from each specimen were observed, establishing a base of 18 seeds examined per species.

The seed testa was removed by initially sonifying (Heat Systems-Ultrasonics, Inc. Sonifer) the seeds for 5 minutes while suspended in a 1:9 mixture of sulfuric acid and acetic anhydride. After soaking in the acid bath for 24 hours, the seeds were removed, and air dried on filter paper for 24 hours. Seeds were then mounted on aluminum stubs using Tube Koat and copper tape, and coated with 30 nm of gold using a Technics Hummer 1 sputter coater. Observations were made using an AMR-1200 SEM.

Phenetic relationships, using characters deemed systematically stable (Table 1), were employed in the construction of a data matrix composed entirely of presence/absence characters and used to construct a phenogram. Unweighted pair-group method using arithmetic averages (UPGMA; Sneath & Sokal 1973) contained within the standard computer package for numerical analysis, NTSYS-PC (Rohlf et al. 1979), was used for data analysis. Two criteria were required of all characters: 1) that they should be scored unequivocally for each species, and 2) that character states differ in at least one species.

The elemental composition of the tegumen surface was assessed by qualitative x-ray analysis using an energy-dispersive spectrometer (Ortec 5000) attached to a Hitachi S-520 SEM.

TABLE 1. Definitions of the 12 characters used in the *Juncus* phenetic analysis.

Character	State			
Reticulae	Absent	Present		
Reticulae size	Pronounced	Large		
Reticulae shape	Rectangular	Square	Hexagonal	Rec/sq
Ret/scrobiculate	Angular	Not angular		
Scrobiculae size	Small	Medium	Large	
Interspace	Shallow	Deep		
Secondary pattern	Lineolate	Costate	Horizontal	Diagonal
Insertion	paired 1 + 1	1 + 2	1 + 0	
Costae form	Branched	Free form	Well-spaced	Dense
Process shape	Angular	Ribbed		
No. of processes	1–4	5–7		
Wall	Smooth	Granular	Processes	Ribbed

RESULTS

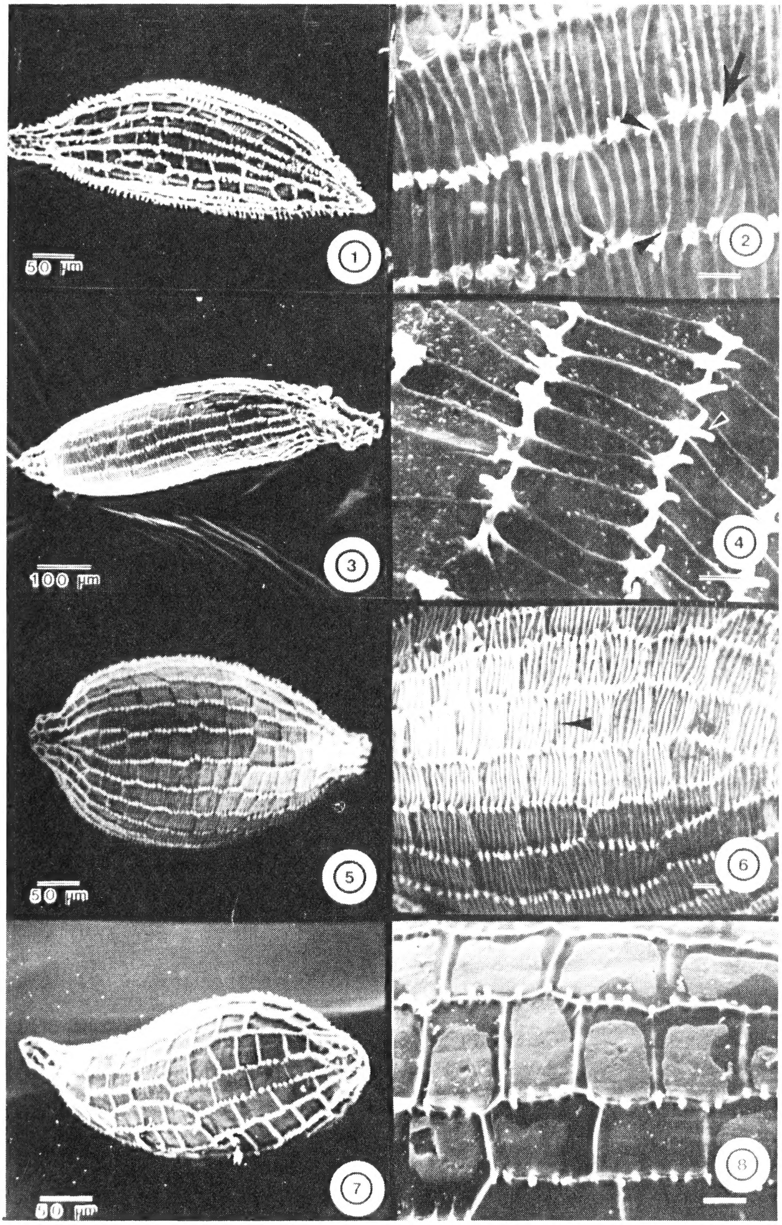
Although the presence of silica is widely known for the closely related families Poaceae and Cyperaceae, elemental analysis did not reveal silica deposits in the tegumen cells observed in this study.

The following is a description of seed morphology within each subgenus of *Juncus* occurring in Michigan, with reference to seed shape and ornamentation (Figs. 1–52).

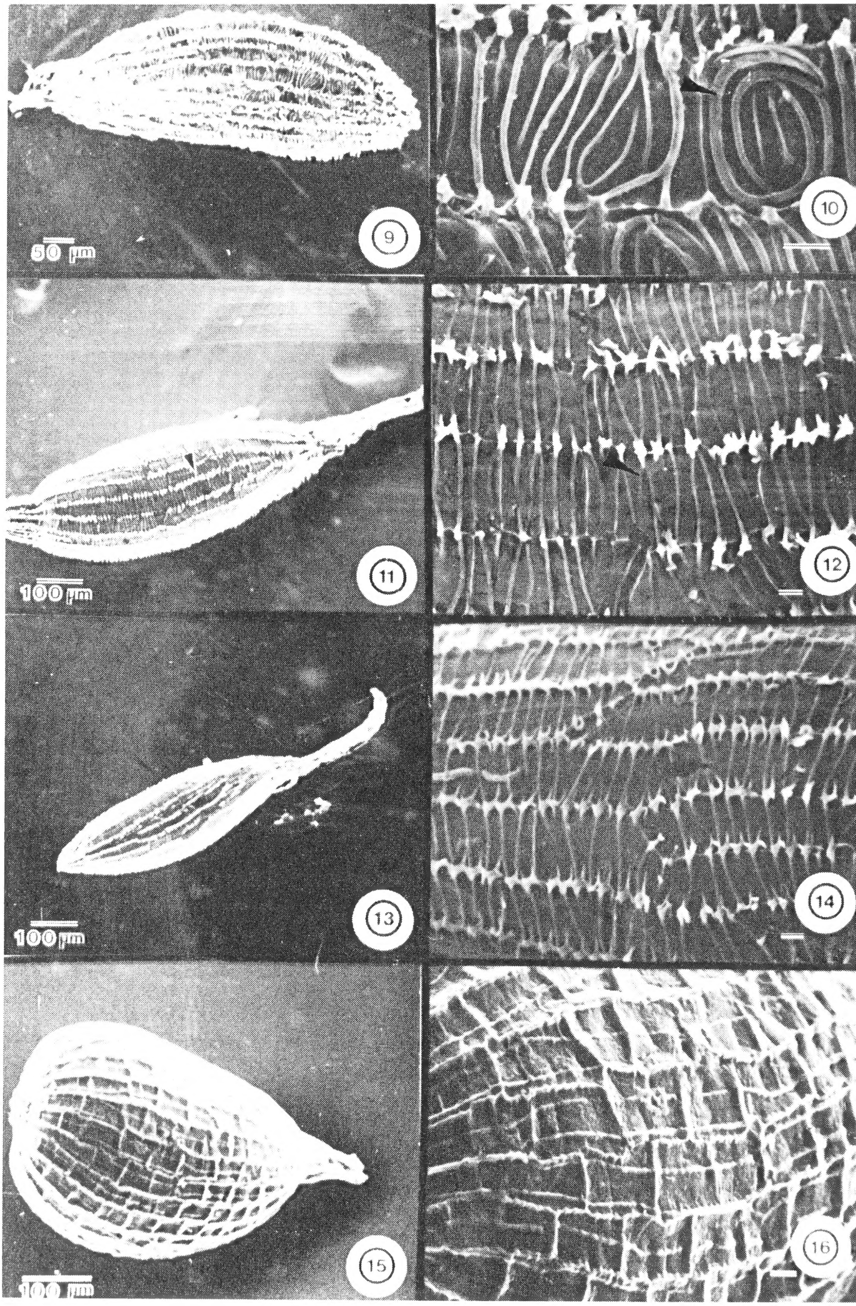
Subgenus Septati *Buchenau (Figs. 1–24)*

As in previously described members of *Septati* (see Brooks & Kuhn 1986; Ertter 1986), a variety of seed shapes were also observed in this study, all typical of subgenus *Septati.* Fusiform shaped seeds were the most common, with only *J. articulatus* L. (Fig. 5), *J. militaris* Bigelow (Fig. 15), *J. nodosus* L. (Fig. 17), and *J. pelocarpus* E. Meyer (Fig. 19) exhibiting broadly fusiform to ellipsoid shapes.

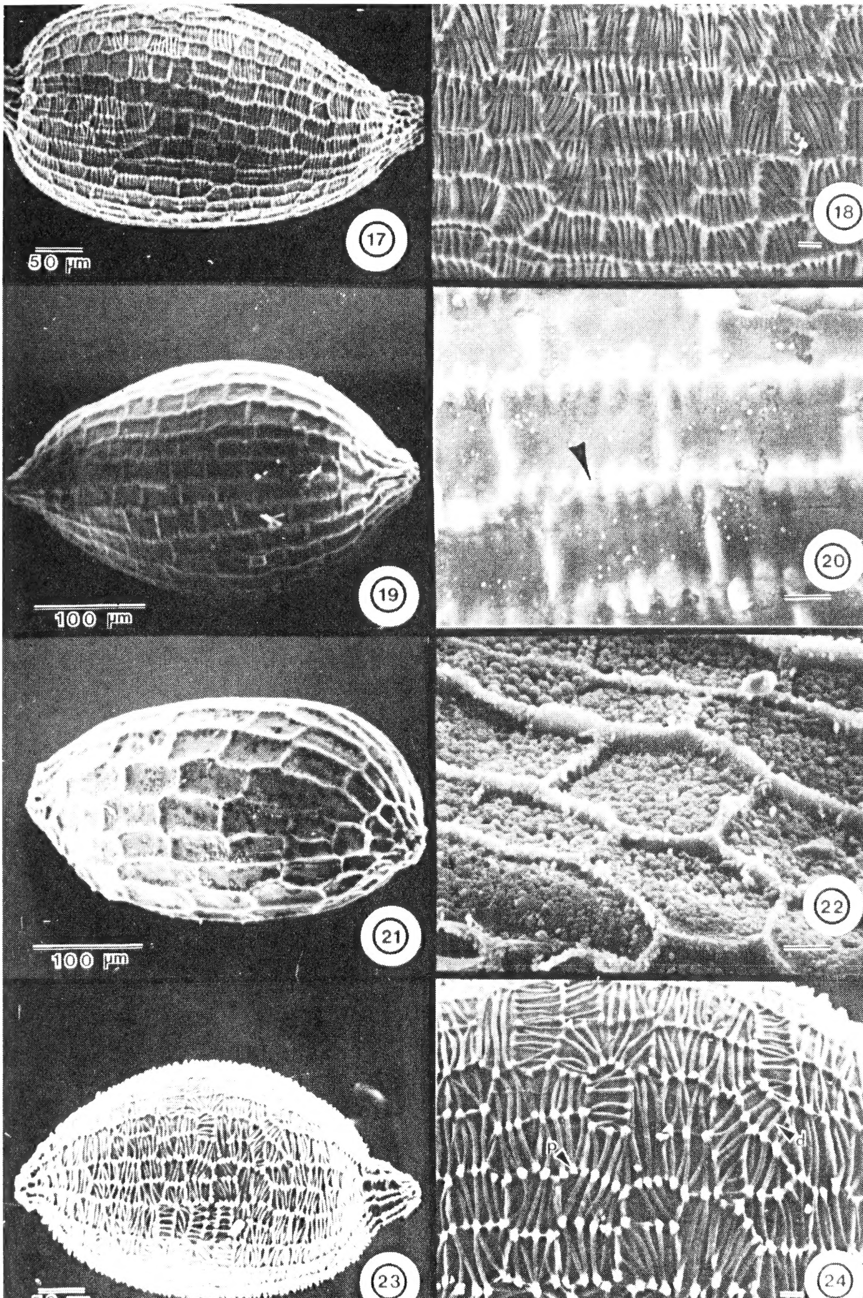
The seed coat sculpturing consists of longitudinal costae connected by transverse ridges, creating a network of longitudinally arranged meshes. These meshes are crossed by narrower transverse lines that create nodules where they meet the longitudinal costae. Secondarily, narrower, longitudinal ridges run down the meshes centrally or usually closer to the costae (Figs. 14, 18). *Juncus brachycarpus* Engelm. (Fig. 8) is an exception to this general pattern by containing nodules but lacking the accompanying transverse lines. While consisting of regularly spaced longitudinal ridges similar to the other taxa within the subgenus, the reticulum of *J. militaris*, *J. nodosus*, *J. pelocarpus* and *J. scirpoides* Lam. (Figs. 16, 18, 20, 22) lacked spines. Both *J. militaris* and *J. nodosus* (Figs. 16, 18) have a secondary pattern, lineolate and costate respectively, while the surface of *J. scirpoides* is completely granulate. The pattern of *J. pelocarpus* (Fig. 20), however, consists of hemispherical processes occurring on the horizontal walls of the



FIGURES 1-8. SEM photomicrographs of seeds of *Juncus*. For each species the whole seed is shown with the outer membranous coat removed and opposite that is a portion of the seed coat. Scale represents 10 μm unless otherwise noted. 1-2. *J. acuminatus* (arrows indicate a pair of costae with a common origin/insertion and a multiple spine). 3-4 *J. alpinoarticulatus* (arrow indicates bifurcate spine). 5-6. *J. articulatus* (arrow indicates pair of costae with common origin/insertion). 7-8. *J. brachycarpus*. (All subg. *Septati*)



FIGURES 9–16. 9–10. *J. brachycephalus* (arrow indicates free-form costae). 11–12. *J. brevicaudatus* (arrow at origin indicates costa with an origin but no insertion). 13–14. *J. canadensis*. 15–16. *J. militaris*. (All subg. *Septati*)



FIGURES 17–24. 17–18. *J. nodosus*. 19–20. *J. pelocarpus* (arrow indicates reduced hemispherical process). 21–22. *J. scirpoides*. 23–24. *J. torreyi* (arrows indicate a reduced process (p) and a diagonal costa (d)). (All subg. *Septati*)

reticulae. This absence of spined ridges is similar to the pattern exhibited by *J. greenei* Oakes & Tuckerman and *J. vaseyi* Engelm. (Figs. 46, 50), both members of subgenus *Poiophylli*. The spines present on other members of *Septati* are either simple, double or bifurcate (Brooks & Kuhn 1986), and/or multiple (Fig. 2).

Voss (1972) has pointed out the problem distinguishing between *J. canadensis* Laharpe and two taxa that were once treated as varieties of this taxon, *J. brevicaudatus* (Engelm.) Fern. and *J. brachycephalus* (Engelm.) Buchenau. Tegumen configuration supports treatment of *J. brevicaudatus* (Fig. 12) as a variety of *J. canadensis* (Fig. 14; see also Fig. 53), but not *J. brachycephalus* (Fig. 10).

Subgenus Graminifolii *Buchenau (Figs. 25–28)*

In Michigan, this subgenus is represented by two species (*J. marginatus* Rostk., *J. biflorus* Elliott. Our micrographs, as did those of Brooks and Kuhn (1986), showed patterns not present in seeds examined by Ertter (1986). The secondary wall pattern consists of costae (Fig. 26) that are well-spaced and a reticulum that is subtle with prominent horizontal ribs.

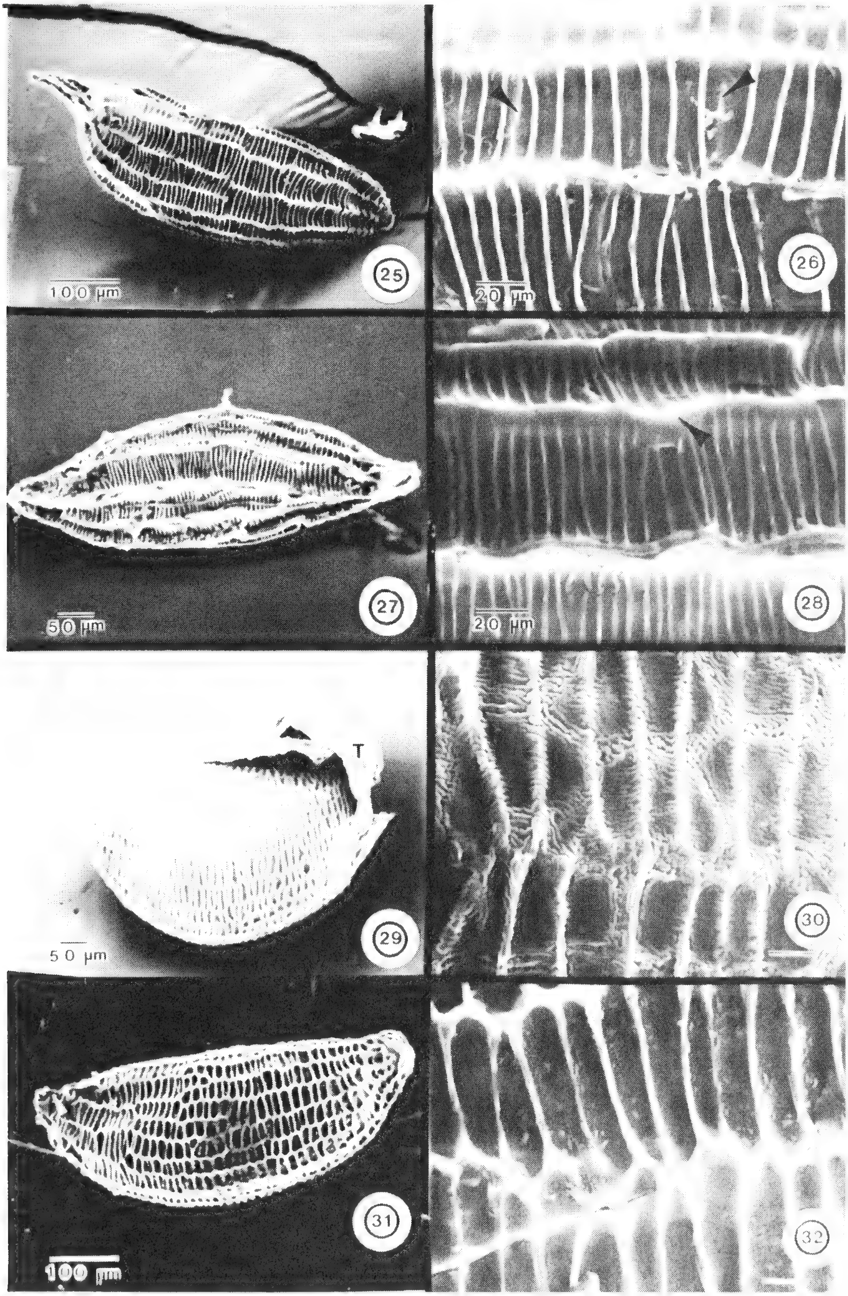
Subgenus Genuini *Buchenau (Figs. 29–36)*

Seed shape ranged from narrowly ellipsoid (Fig. 31) to ovoid in the large seeds of *J. balticus* Willd. (Fig. 29).

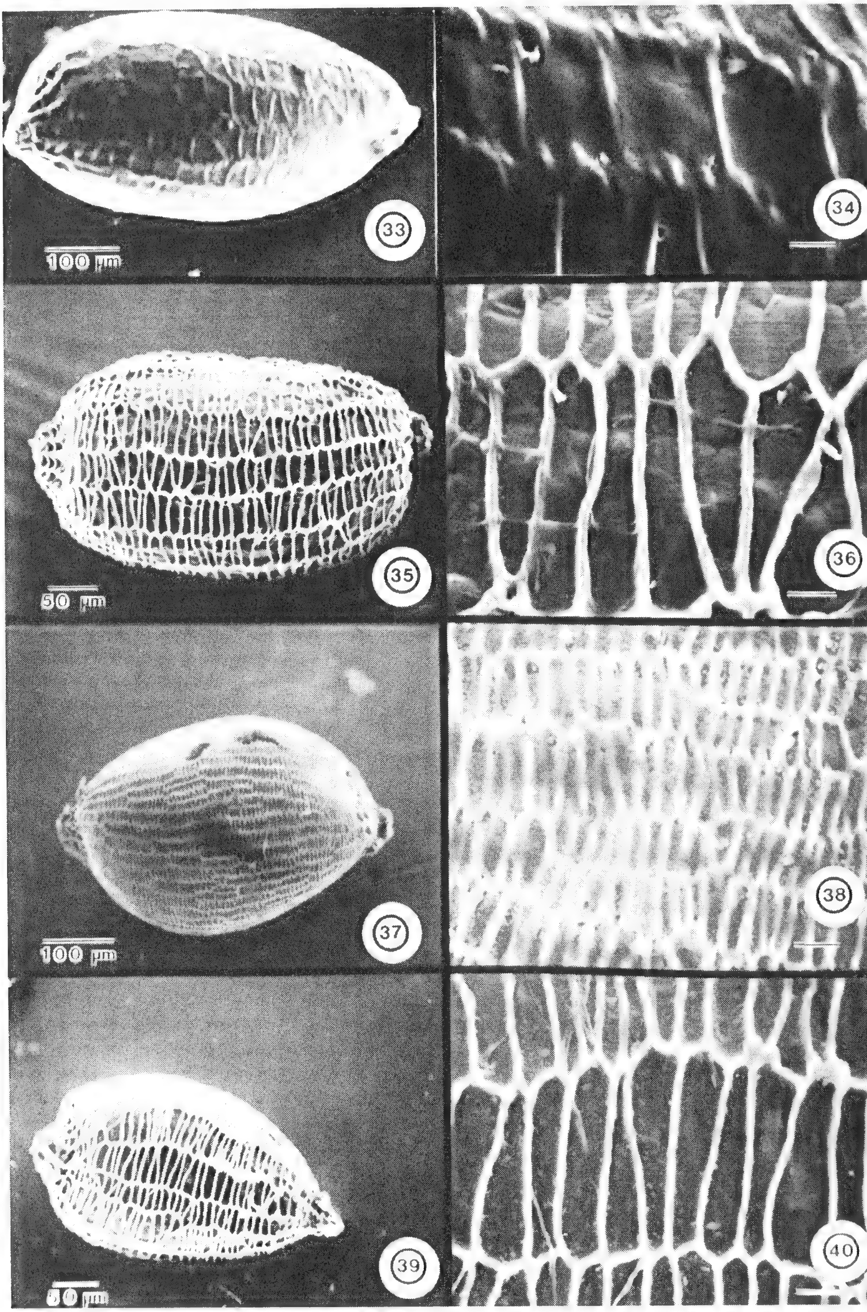
This subgenus exhibited the greatest seed coat variation. The only species possessing a hint of ridge ornamentation was *J. filiformis* L. (Fig. 34). *Juncus balticus*, *J. inflexus* L. (Fig. 36), and taxa of the *J. effusus* L. complex have reticulate-scrobiculate patterns of ornamentation (Clements 1979) that are subtly distinguishable. *Juncus balticus* is distinguished by a species-specific rugose surface, while taxa of the *J. effusus* complex possess a deep interspace (Zech 1986). It should be noted that Clements (1979) did not examine the *J. effusus* complex; seed coat pattern in this complex, as observed using SEM, is relatively stable within and characteristic of the species, in spite of specific patterns that are present within a given variety. Of the nine *J. effusus* complex varieties studied, all exhibited the reticulate-scrobiculate and deep interspace configuration. Based on these characters the complex is treated as a single taxon, *J. effusus*, within the phenogram. Additional data on the varieties within this species complex will be reported later.

Subgenus Poiophylli *(Buchenau) Vierh. (Figs. 37–50)*

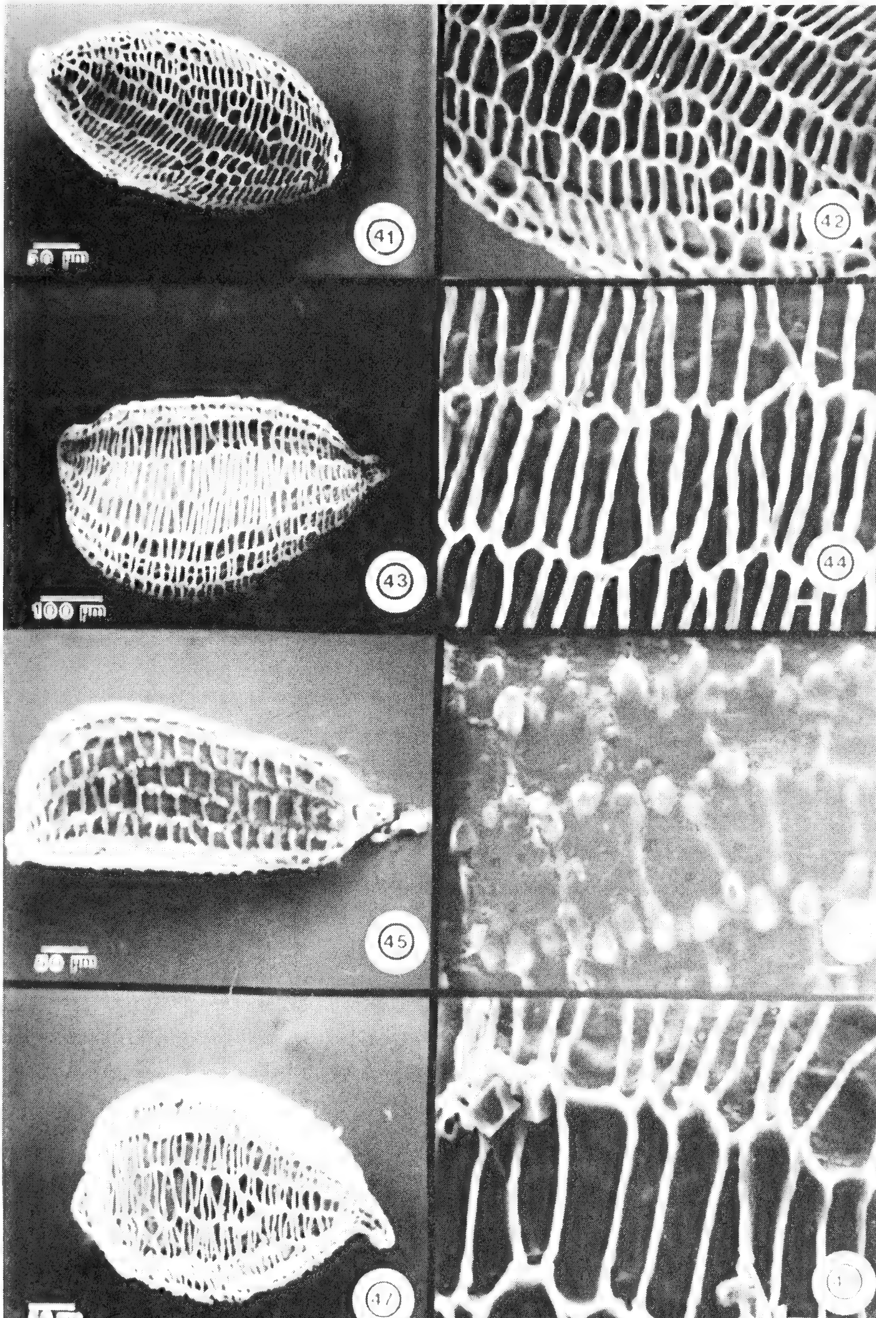
Our findings are not in complete agreement with those of Brooks and Kuhn (1986). While they were unable to distinguish between the five taxa they examined (*J. bufonius* L., *J. brachyphyllus* Wieg., *J. dudleyi* Wieg., *J. interior* Wieg., *J. tenuis* Willd.), we were able to distinguish between all of the Michigan taxa on the basis of seed shape and ornamentation. Although not reported as occurring in Michigan (Voss 1972), *J. compressus* Jacq.



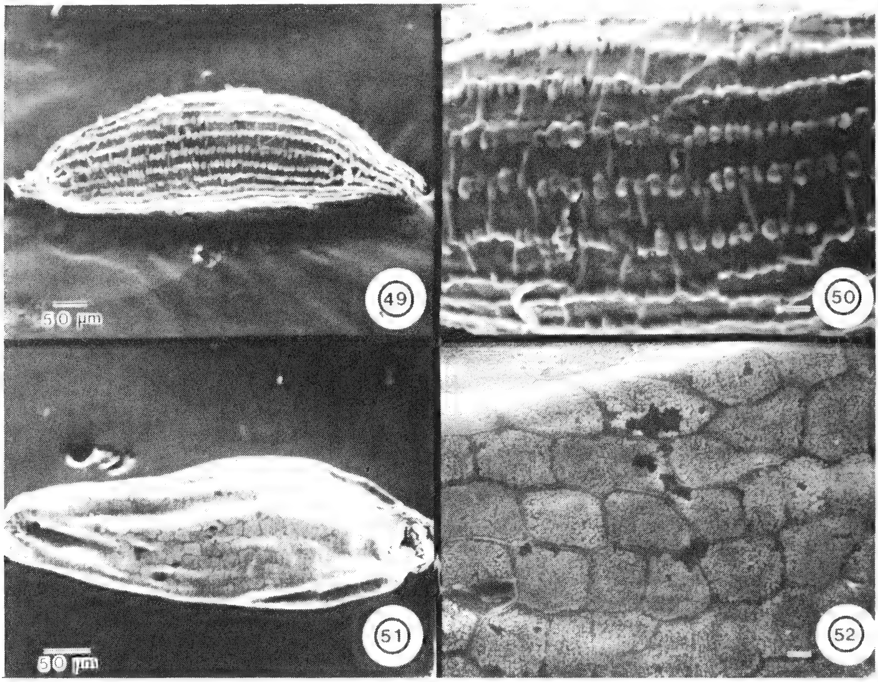
FIGURES 25-32. 25-26. *J. biflorus* (arrows indicate longitudinal walls of a subtle reticulae). 27-28. *J. marginatus* (arrow indicates a horizontal rib). (Both subg. *Graminifolii*). 29-30. *J. balticus*. 31-32. *J. effusus* var. *costulatus*. (Both subg. *Genuini*)



FIGURES 33–40. 33–34. *J. filliformis*. 35–36. *J. inflexus*. (Both subg. *Genuini*). 37–38. *J. bufonius*. 39–40. *J. compressus*. (Both subg. *Poiophylli*)



FIGURES 41–48. 41–42. *J. dudleyi*. 43–44. *J. gerardii*. 45–46. *J. greenei*. 47–48. *J. tenuis*. (All subg. *Poiophylli*)



FIGURES 49-52. 49-50. *J. vaseyi*. (Subg. *Poiophylli*). 51-52. *J. stygius*. (Subg. *Alpini*)

(Figs. 39-40) has been recently collected near Ann Arbor (Reznicek, unpub.). Now widespread along Michigan highways (Reznicek, unpub.), macroscopically it most closely resembles *J. gerardii* Lois. (Figs. 43-44). *Juncus greenei* and *J. vaseyi* (Figs. 45-46, 49-50), while readily distinguishable, both possess spines that are hemispherical; other members of the subgenus lack such secondary ornamentations. These prominent longitudinal ridges have also been recently illustrated by Catling and Spicer (1988) in *J. vaseyi*. *Juncus dudleyi* (Figs. 41-42) has been treated as a variety of *J. tenuis* (Figs. 47-48: Hermann 1975; Boivin 1979); seed ornamentation supports Catling and Spicer's (1987) study in recognizing them at the species level.

Subgenus Alpini *Buchenau (Figs. 51-52)*

Juncus stygius L. (Figs. 51-52) is distinguished from all other *Juncus* taxa by its lack of secondary wall ornamentation. The reticulae are somewhat hexagonal in shape with only granules within the aerolae.

DISCUSSION

This study indicates that seed surface morphology is useful in suggesting relationships at both the subgeneric and specific levels. Using tegumen ornamentation, 12 characters were identified for phenetic analysis. Qualitative characters were chosen since variability in seed size produces variation in tegumen configuration size. Additional characters such as seed length and width were not utilized as this study dealt exclusively with tegumen ornamentation.

Of the eight *Juncus* subgenera (Buchenau 1890), five have species that occur in Michigan (see Appendix). Two of the five contain taxa which clustered together (Fig. 53). Phenetic patterns are patterns of overall resemblance and difference among organisms on many heritable characteristics. Often there are discontinuities so that the pattern reveals groupings with different ranges of variation within a group and varying degrees of differences between them. These patterns are usually observed among organisms at a given time (Stace 1980).

A cophenetic correlation is a measure of the agreement between the similarity values implied by the phenogram and those of the original similarity matrix. The simplicity of the cophenetic correlation coefficient has led to its extensive application (Sneath & Sokal 1973). It has generally been found to vary from 0.6 to 0.95, depending on the method producing the phenogram (UPGMA in this study) and the natural structure of the species being classified; our phenogram had a cophenetic correlation of 0.8938. Of the four main clustering methods, UPGMA (unweighted pair-group method using arithmetic averages) is the most frequently used (Romesburg 1984) and also appears to produce the best results (Radford, 1986). This algorithm computes the average similarity or dissimilarity of an OTU (operational taxonomic unit; the lowest ranking taxa employed in a given study, species in this study) to an extant cluster, weighing such species in that cluster equally (Sneath & Sokal 1973).

Several problems arise when comparing the phenetic analysis and Buchenau's (1890) subgenera. While several of the Michigan species clustered at the subgeneric level recognized by Buchenau (*Alpini*, *Graminifolii*), it must be remembered that only a minimal number of species occur in Michigan, but even here these two subgenera were nested within two other subgenera, *Septati* and *Poiophylli*. Results may vary if all taxa within a subgenus were examined. Furthermore, when looking at the remaining three subgenera occurring in Michigan, it is not difficult to see that the species included do not comprise uniform taxonomic groups based solely on their tegumen configuration. Brisson and Peterson (1976) have pointed out the tendency of SEM investigators to base taxonomic representation on insufficient sampling and remind that seed coat patterning as a useful diagnostic character depends upon the amount of variation that exists within and between the taxa. However, using only 4–6 seeds, Kruse (1984) in his study of *Allium*, a genus in the closely-related family Liliaceae, confirmed

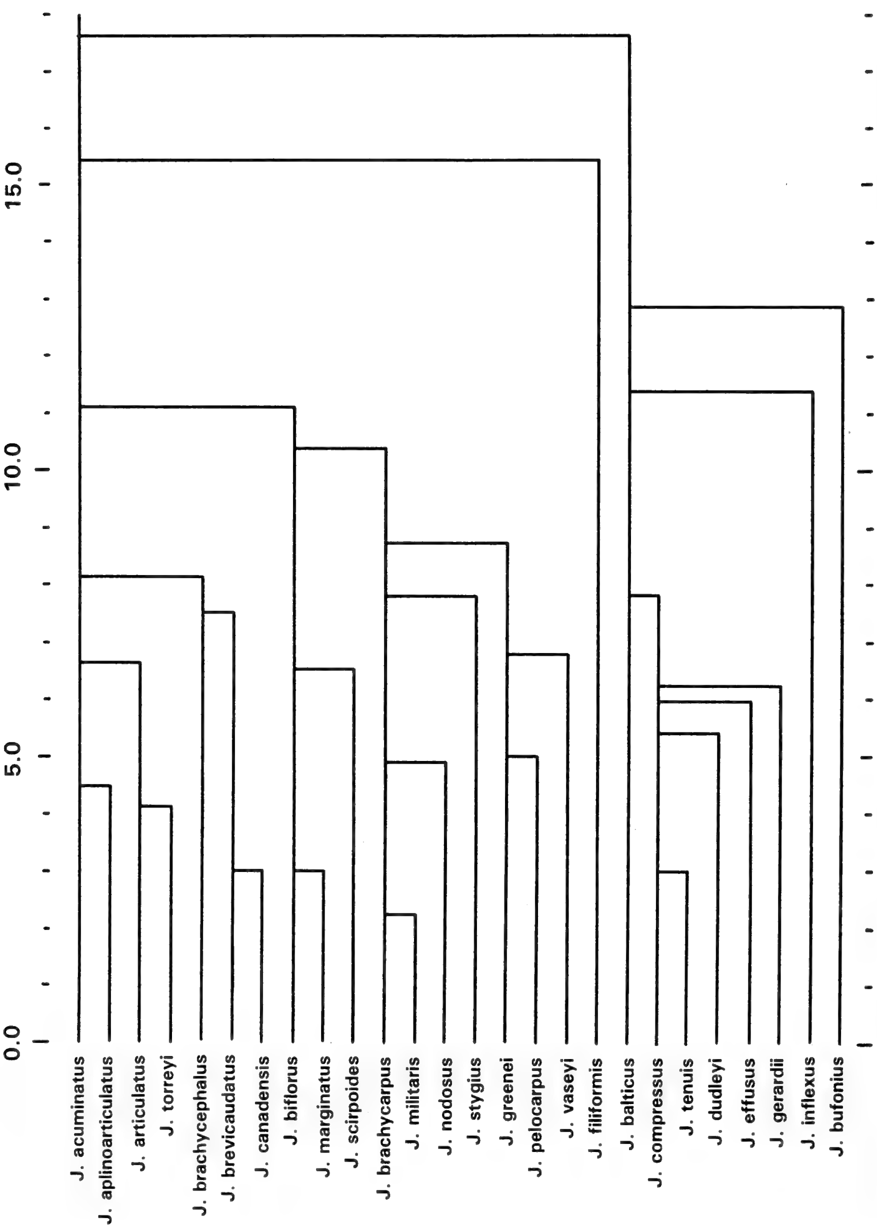


FIGURE 53. Phenogram of Michigan *Juncus* species based on an unweighted pair method analysis with a scale of similarity from 0–18. The cophenetic correlation coeffecient = 0.8938.

seed coat morphology is a useful character at the section level, and one that needs to be included as part of the description of the species.

The present data, as well as the studies of Brooks and Kuhn (1986), Ertter (1986), and Catling and Spicer (1988) are preliminary steps in the analysis of seed coat morphology and proposed classifications. While all of the taxa could be distinguished based solely on tegumen characters (Fig. 53), only two of Buchenau's subgenera clustered together. These results support a larger scale examination of seed coat characters to encompass a world-wide study of *Juncus*.

ACKNOWLEDGMENTS

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APPENDIX: Voucher Information

Juncus acuminatus Michaux: MICHIGAN: Houghton Co, *Farwell 10493* (MICH); Mason Co., *Voss 3264* (MICH); Muskegon Co., *Reznicek 6604* (MICH); Oceana Co., *Jordal 3323* (MICH); St Clair Co., *Dodge 714** (MICH); Wayne Co., *Bigelow s.n.* (MICH).

Juncus alpinoarticulatus Chaix: MICHIGAN: Emmet Co., *Ehlers 5093* (MICH); Gogebic Co., *Voss 13710* (MICH); Isabella Co., no collector *7915** (CMC); Keweenaw Co., Isle Royale, McFarland 2412* (MICH); Jackson Co., *Hermann 9302* (MICH); Mackinac Co., *Ehlers 5490* (MICH); Washtenaw Co., *Gustafson s.n.*, (MICH).

Juncus articulatus L.: INDIANA: Lagrange Co., *Deam 6772* (MICH). MICHIGAN: Alger Co., *Voss 2322* (MICH); Allegan Co., *Dodge s.n.** (MICH); Cheboygan Co., *Voss 2322* (MICH); Ogemaw Co., *Loche 208* (MICH); Schoolcraft Co., *Harriman 10486* (MICH); Washtenaw Co., *Hermann 735b* (MICH).

Juncus balticus Willd.: MICHIGAN: Bay Co., *Freudenstein 296* (MICH); Houghton Co., *Hermann 888* (MICH); Mason Co., *Hazlett 742* (MICH); Ottawa Co., *Kauffmann s.n.* (MICH); Schoolcraft Co., *Ehlers 4381** (MICH); Wayne Co., *Bigelow s.n.* (MICH). OHIO: Erie Co., *Deam s.n.* (MICH).

Juncus biflorus Elliott: INDIANA: Jasper Co., *Deam 57965* (MICH); Lawrence Co., *Kriebel 2053** (MICH). MICHIGAN: Berrien Co., *James 604* (MICH); Kent Co., *Bazuin 2009* (MSC). MISSOURI: Texas Co., *Steyermark 19311* (MICH). OHIO: Erie Co., *Cusick 22831* (MICH).

Juncus brachycarpus Engelm.: INDIANA: Lawrence Co., *Kriebel 1532* (MICH). KENTUCKY: Lincoln Co., *McFarland 4150* (MICH). MICHIGAN: Monroe Co., *Farwell 5908* (MICH), *Farwell 8093** (MICH). MISSOURI: Near St. Louis, *Sladefelter 713* (MICH). OHIO: Lucas Co., *Moseley s.n.* (MICH).

Juncus brachycephalus (Engelm.) Buchenau: MICHIGAN: Cheboygan Co., *Ehlers 6140* (MICH); Chippewa Co., *Hermann 7088** (MICH); Emmet Co., *Ehlers s.n.* (MICH); Livingston Co., *Ehlers 5529* (MICH); Mackinac Co., *Cochrane 1098* (MICH); Washtenaw Co., *Hermann 6429** (MICH).

Juncus brevicaudatus (Engelm.) Fern.: MICHIGAN: Alger Co., *Hermann 6400* (MICH); Montcalm Co, *Davis s.n.* (MICH); Otsego Co., *Hermann 7320* (MICH); Roscommon Co., *Hurton 1700** (MICH); Schoolcraft Co., *Hermann 6293.5* (MICH); Wayne Co., *Farwell 511* (MSC). WISCONSIN: Ashland Co., *Fassett 16160 (MICH).*

Juncus bufonius L: MICHIGAN: Alcona Co., *Freudenstein 257* (MICH); Chippewa Co., *Hermann 7101* (MICH); Delta Co., *Voss 4730** (MICH); Emmet Co., *Wood 8175* (MICH); Monroe Co., *Easterly 11913* (MICH); St. Clair Co., *Dodge 23447* (MSC).

Juncus canadensis Laharpe: MICHIGAN: Houghton Co., *Farwell 12731* (MICH); Ionia Co., *Wheeler s.n.** (MICH); Kent Co., *Cole s.n.** (MICH); Keweenaw Co., *Farwell 13064* (MICH); Midland Co., *McVaugh 11073* (MICH); Saginaw Co., *Freudenstein 236* (MICH).

Juncus compressus Jacq.: CANADA: Manitoulin Island, Ontario, *Morton NA14522* (MICH); Saint-Jean, Quebec, *Marie-Victorin 2158* (MICH). MICHIGAN: Monroe Co., *Reznicek 5744** (MICH); Washtenaw Co., *Reznicek 6393* (MICH). MONTANA: Beaverhead Co., *Hermann 12484* (MICH). WISCONSIN: Winnebago Co., *Harriman s.n.* (MICH).

Juncus dudleyi Wieg.: MICHIGAN: Bay Co., *McVaugh 14733** (MICH); Charlevoix Co., *Clover 180* (MICH); Houghton Co., *Herman 8107* (MICH); Keweenaw Co., *Farwell 12552* (MICH), *Farwell 12566* (MICH), Isle Royale, *Brown 3538* (MICH); Saginaw Co., *Freudenstein 234* (MICH); Washtenaw Co., *Grassl 7727* (MICH).

Juncus effusus var. *brunneus* Engelm.: CALIFORNIA: Monterey Co., *Smith s.n.* (MICH); San Francisco, *Kellogg s.n.* (MICH). WASHINGTON: Pacific Co., *Suksdorf s.n.* (MICH).

Juncus effusus var. compactus Lej. & Court: MICHIGAN: Houghton Co., *Hermann s.n.* (MICH), *Hermann s.n.* (MICH) (two specimens); Wayne Co., *Farwell s.n.* (MICH).

Juncus effusus var. *conglomeratus* Engelm.: CANADA: New Brunswick, *Fowler s.n.* (MICH). GREAT BRITAIN: *Cole s.n.* (MICH), *Pease 8005* (MICH).

Juncus effusus var. *costulatus* Fern.: CONNECTICUT: Windham Co., *Carrell 7437* (MICH). NEW JERSEY: Burlington Co., *Hermann s.n.* (MICH), *Hermann s.n.** (MICH) (two specimens).

Juncus effusus var. *decipiens* Buchenau: MICHIGAN: Arenac Co., *Locke s.n.* (MICH); Chippewa Co., *Hermann 7122* (MICH); Newaygo Co., *Hermann s.n.* (MICH).

Juncus effusus var. *gracilus* Hook.: WASHINGTON: Klickitat Co., *Suksdorf s.n.* (MICH), *Suksdorf s.n.* (MICH) (two specimens). KOREA: *Smith s.n.* (MICH).

Juncus effusus var. *pacificus* Fern. & Wieg.: CALIFORNIA: Humboldt Co., *Howell s.n.* (MICH). OREGON: Benton Co., *Wentz s.n.* (MICH).

Juncus effusus var. *pylaei* (Laharpe) Fern. & Wieg.: MICHIGAN: Cheboygan Co., *Ehlers 7047* (MICH); Chippewa Co., *Hermann 7211* (MICH); Houghton Co., *Farwell 11470* (MICH); Ottawa Co., *Robertson 752* (MICH).

Juncus effusus var. *solutus* Fern. & Wieg.: MICHIGAN: Alpena Co., *Dodge 507* (MICH): Chippewa Co., *Dodge 705b* (MICH); St. Clair Co., *Dodge 705* (MICH).

Juncus filiformis L.: CANADA: New Brunswick, *Reznicek 5014* (MICH); Algoma District, Ontario, *Hosie, Harrison, & Hughes 1393* (MICH); Magdalen Islands, Quebec, *Fernald 7146* (MICH). MICHIGAN: Baraga Co., *Dreisbach 6922** (MICH); Chippewa Co., *Voss 12509* (MICH). WISCONSIN: Iron Co., *Voss 10013* (MICH).

Juncus gerardii Lois: CONNECTICUT: New Haven Co. *Dudley s.n.* (MICH). INDIANA: Howard Co., *Deam 57045* (MICH). MASSACHUSETTS: Barnstable Co., *Bartlett 1297** (MICH); Essex Co., *Forbes s.n.* (MICH); no county, *Bartlett s.n.* (MICH). MICHIGAN: St. Clair Co., *Reznicek 5409* (MICH); Wayne Co., *Farwell 8897** (MICH).

Juncus greenei Oakes & Tuckerman: MICHIGAN: Berrien Co., *Voss 15366* (MICH); Chippewa Co., *Dodge 702** (MICH); Huron Co., *Dreisbach 8567* (MICH); Oakland Co., *Farwell 5589* (MICH); Schoolcraft Co., *Henson 1427* (MICH). OHIO: Lucas Co., *Cusick 21789* (MICH).

Juncus inflexus L.: CANADA: Algoma District, Ontario, *Garton 14257* (MICH). MICHIGAN: Houghton Co., *Hermann 9682** (MICH), *Hermann 9203* (MICH, MSC), *Farwell 12735* (MSC). VIRGINIA: Bland Co., *Harvill 37873* (MICH).

Juncus marginatus Rostk.: KENTUCKY: Harlan Co., *Kearney 23040* (MSC). MICHIGAN: Saginaw Co., *Freudenstein 240* (MICH); Tuscola Co., *Churchill 225227** (MSC). OKLAHOMA: no county, *DeBarr 446* (MSC). TEXAS: Travis Co., *Tharp 10539* (MSC); Van Zandt Co., *Smith 274794* (MICH).

Juncus militaris Bigelow: CANADA: Havelock, Nova Scotia, *Fernald 446* (MICH); Parry Sound, Ontario, *Simpson 1337* (MICH). MASSACHUSETTS: Worcester Co., *Robbins s.n.* (MICH), *Robbins 53* (MICH). MICHIGAN: Cheboygan Co., *Ehlers 6159* (MICH), *Voss 11348** (MICH).

Juncus nodosus L.: MICHIGAN: Huron Co., *Wheeler 711* (MICH); Kent Co., *Cole s.n.* (MICH); Mackinac Co., *Erlanson 678** (MICH); Menominee Co., *Grassl 3810* (MICH); Washtenaw Co., *Gustafson s.n.* (MICH).

Juncus pelocarpus E. Meyer: MICHIGAN: Alger Co., *Bailey 229* (MICH); Cass Co., *Schuyler 1015* (MICH); Chippewa Co., *Hermann 7029* (MICH); Kent Co., *Cole s.n.* (MICH); Mason Co., *Voss 3256* (MICH); Presque Isle Co., *Hermann 7009** (MICH).

Juncus scirpoides Lam.: FLORIDA: Sarasota Co., *Blanchard s.n.* (MICH). INDIANA: Porter Co., *Deam 56630* (MICH). MICHIGAN: Berrien Co., *Evans s.n.** (MICH); Kalamazoo Co., *Hanes 32-183* (MICH). NEW JERSEY: no county, *Dreisbach 1824* (MICH). NORTH CAROLINA: Pender Co., *Ahles 32348* (MICH). PENNSYLVANIA: Delaware Co., *Smith 65* (MICH). TEXAS: Atascosa Co., *Hermann s.n.* (MICH).

Juncus stygius L: CANADA: New Brunswick, *Clinton 2470* (MSC); Bass River, New Brunswick, *Fowler s.n.* (MICH); Thunder Bay, Ontario, *Voss 13517* (MICH); Bonaventure City, Quebec, *Collins & Fernald 4753* (MICH); Gaspe Co., Quebec, *Fernald 192* (MSC); Saskatchewan, *Argus 493-63** (MICH).

Juncus tenuis Willd.: MICHIGAN: Cheboygan Co., *Ehlers 7082* (MICH); Chippewa Co., *Hermann 7033* (MICH); Livingston Co., *Hammerstrom 257* (MICH); Marquette Co., *Pringle 854** (MICH); Monroe Co., *Farwell 6992* (MICH); Roscommon Co., *Wentz 992* (MICH).

Juncus torreyi Cov.: INDIANA: LaPorte Co., *Deam s.n.* (MICH). MICHIGAN: Isabella Co., *Huber 7860* (CMC); Kent Co., *Morcelline 2900* (MICH); Manistee Co., *Umbach 8311** (MICH); Presque Isle Co., *Stuckey 1336* (MICH); Van Buren Co., *Hanes s.n.* (MICH). OHIO: Hancock Co., *Cusick 21883* (MICH).

Juncus vaseyi Engelm.: CANADA: Thunder Bay, Ontario, *Garton 19106* (MICH).

MICHIGAN: Cheboygan Co., *Ehlers 5300* (MICH); Delta Co., *Dodge 701** (MICH); Schoolcraft Co., *Hermann 8293* (MICH); Wayne Co., *Bigelow s.n.* (MICH), *Holzer s.n.* (MICH).

* Specimens represented by micrographs.

EDITORIAL NOTICE: LIST OF REVIEWERS

We wish to thank the following people who have reviewed articles for *The Michigan Botanist* during 1989. Their comments were essential, helping our authors to prepare clear, succinct text and us in our position as editors. Their assistance is gratefully acknowledged.

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LICHENS OF PICTURED ROCKS NATIONAL LAKESHORE, MICHIGAN

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Pictured Rocks National Lakeshore is located in northern Michigan along the southern shore of Lake Superior east of the Keweenaw Peninsula. The park extends in a narrow strip about 75 miles along the shore. The eastern part has sand bluffs along the lake and the western part has sandstone cliffs. Many of the sand beach areas have stands of jack pine (*Pinus banksiana* Lambert), red pine (*Pinus resinosa* Aiton) and some white pine (*Pinus strobus* L.). In some areas there are hemlock (*Tsuga canadensis* (L.) Carrière) and balsam fir (*Abies balsamea* (L.) Miller) and white spruce (*Picea glauca* (Moench.) Voss). Above the rock cliffs there is a hardwood forest of beech (*Fagus grandifolia* Ehrh.), sugar maple (*Acer saccharum* Marshall) and red maple (*Acer rubrum* L.). Areas of quaking aspen (*Populus tremuloides* Michaux) occur in many areas of second growth forest. Along the streams and in some low areas are stands of white cedar (*Thuja occidentalis* L.) and balsam fir with some black ash (*Fraxinus nigra* Marshall). Most of the region was extensively logged earlier this century and most of the vegetation is second growth. On the sand plains south of the park regrowth has been very slow and large areas remain of stumps and open growth pines.

The only literature records for lichens in the park were published by Lowe (1935; one species) and Hedrick (1939; 28 taxa) in which they mentioned some lichens collected at Miners Falls and Miners Castle in 1933. There are probably other unreported collections in some of the state herbaria (e.g., Michigan State, University of Michigan). The lichen flora prior to logging may have been richer in some genera but the sand plain regrowth areas are probably richer now due to the large areas of open poorly vegetated sand.

Field work was done during July, 1987. Collections in the park were made at 25 localities and 1231 lichen collections were obtained. One locality (one mile north of Kingston Lake) is in the buffer area outside of the main park boundary but the species collected there are included in the list. A complete list of collection localities is given in the locality list and are indicated in Fig. 1. Localities for collecting were selected first to give a general coverage of the park, second, to sample all vegetational types, and third, to be in localities that should be rich in lichens. Disturbed as well as undisturbed areas were included. At each locality voucher specimens of all species found were collected to record the total flora for each locality. Identifications were carried out at the University of Minnesota. The origi-

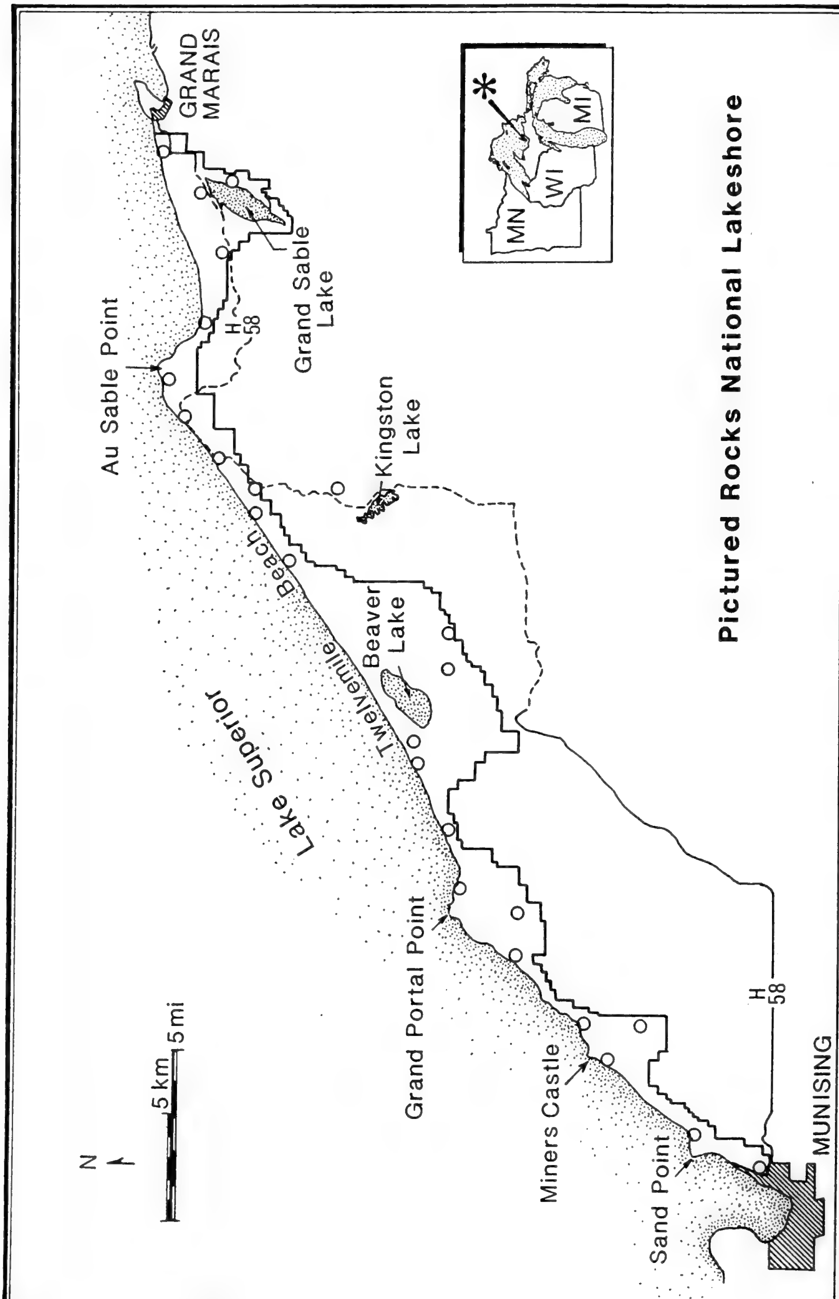

FIGURE 1. Pictured Rocks National Lakeshore showing collection localities. Open circles are localities where complete collections were made.

nal packet of each collection has been deposited in the University of Minnesota Herbarium and a representative set of duplicates has been sent to the park and to the Smithsonian Institution. All specimens deposited at the University of Minnesota have been entered into the herbarium computerized data base.

LICHEN FLORA

The following list of 235 lichens is based on my collections at 25 localities. The taxa reported by Lowe (1935) and Hedrick (1939) are not listed because I have not seen those specimens. The species found only once in the park are indicated by "Rare." Each species is followed by the locality number where it was found unless if occurred at 6 or more, and then it is called "Common" followed by the number of different localities. Additional distribution notes are based on specimens in MIN and the literature.

Anaptychia palmulata (Michaux) Vain. 15, 23

Anaptychia setifera Räs. 1, 3, 4, 5

Arthonia caesia (Flot.) Körb. 4, 20, 25

Arthonia didyma Körb. Rare 9

Arthonia diffusella Fink in Hedr. Rare 15. This species has also been collected on the Slate Islands, Ontario and the shores of eastern Lake Superior in Ontario.

Arthonia fuliginosa (Schaer.) Flot. 9, 14. Also known from northern Minnesota, Isle Royale and the Slate Islands, Ontario.

Arthonia patellulata Nyl. Rare 7

Arthonia punctiformis Ach. Rare 4

Arthonia radiata (Pers.) Ach. Common, 6 loc.

Bacidia accedens (Arn.) Lett. Rare 24

Bacidia epixanthoides (Nyl.) Lett. Rare 13

Bacidia naegelii (Hepp) Zahlbr. Rare 1

Bacidia polychroa (Th. Fr.) Körb. Rare 5

Bacidia rubella (Hoffm.) Mass. 3, 4, 5

Bacidia schweinitzii (Tuck.) Schneid. Common, 7 loc.

Bacidia spaeroides (Dicks.) Zahlbr. Rare 13

Bacidia suffusa (Fr.) Schneid. 2, 4, 9, 18, 19

Bryoria furcellata (Fr.) Brodo & Hawksw. Common, 13 loc.

Bryoria nadvornikiana (Gyeln.) Brodo & Hawksw. Rare 1

Bryoria trichodes (Michaux) Brodo & Hawksw. 1, 8

Buellia arnoldii Serv. 4, 15, 17, 21, 24

Buellia disciformis (Fr.) Mudd Common, 10 loc.

Buellia punctata (Hoffm.) Mass. 20, 22, 25

Buellia schaereri De Not. 1, 5, 16, 17

Buellia stillingiana Steiner Common, 9 loc.

Calicium abietinum Pers. Rare 17

Calcium trabinellum (Ach.) Ach. 6, 10, 15

Caloplaca cerina (Ehrh. ex Hedw.) Th. Fr. 7, 11

Caloplaca chrysophthalma Degel. Rare 23

Caloplaca holocarpa (Hoffm.) Wade 3, 4, 11, 20

Candelaria concolor (Dicks.) B. Stein 2, 3, 14, 19

Candelariella efflorescens R. Harris & Buck 13, 19, 20

Candelariella vitellina (Hoffm.) Müll. Arg. Rare 20

Catillaria nigroclavata (Nyl.) Schuler Rare 4

Catinaria laureri (Hepp ex Th. Fr.) Degel. 2, 3, 5, 14

Cetraria arenaria Kärnef. Rare 1

Cetraria halei W. Culb. & C. Culb. Common, 8 loc.

Cetraria oakesiana Tuck. Common, 11 loc.

Cetraria orbata (Nyl.) Fink 7, 10, 21, 22

Cetraria pinastri (Scop.) Gray Common., 10 loc.

Cetraria sepincola (Ehrh.) Ach. 6, 11

Cetrelia chicitae (W. Culb.) W. Culb. & C. Culb. Rare 18'

Cetrelia olivetorum (Nyl.) W. Culb. & C. Culb. 9, 15, 23, 24
Chaenotheca brunneola (Ach.) Müll. Arg. 5, 9, 18, 21, 24
Chaenotheca chrysocephala (Turn. ex Ach.) Th. Fr. 18, 21, 24
Chaenotheca ferruginea (Turn. ex Sm.) Mig. 10, 17, 21
Chaenotheca laevigata Nadv. Rare 21
Chaenotheca stemonea (Ach.) Zw. Rare 18
Chaenotheca trichialis (Ach.) Th. Fr. 12, 18
Chaenothecopsis savonica (Räs.) Tibell, 5, 9, 12. Also known from northern Minnesota, northern Wisconsin, and northern Michigan.
Chrysothrix candelaris (L.) Laund. Rare 8. Also known from northern Minnesota, Isle Royale, and northern Wisconsin.
Cladina arbuscula (Wallr.) Hale & W. Culb. 7, 22
Cladina mitis (Sandst.) Hustich Common, 7 loc.
Cladina rangiferina (L.) Nyl. Common, 12 loc.
Cladina stellaris (Opiz) Brodo Common, 6 loc.
Cladina stygia (Fr.) Ahti 10, 11, 15, 16, 23. This species is more common in the northern Great Lakes region.
Cladonia botrytes (Hagen) Willd. Rare 11
Cladonia caespiticia (Pers.) Flörke 20, 24
Cladonia cenotea (Ach.) Schaer. 6, 7, 8, 24, 25
Cladonia chlorophea (Flörke ex Somm.) Spreng. 7, 13, 20, 22, 25
Cladonia coniocraea (Flörke) Spreng. Common, 17 loc.
Cladonia cornuta (L.) Hoffm. Common, 6 loc.
Cladonia crispata (Ach.) Flot. Common, 8 loc.
Cladonia cristatella Tuck. Common, 6 loc.
Cladonia cryptochlorophaea Asah. 11, 17, 25
Cladonia deformis (L.) Hoffm. Common, 7 loc.
Cladonia digitata (L.) Hoffm. 8, 10, 11, 12
Cladonia fimbriata (L.) Fr. 4, 11, 19, 25
Cladonia floerkeana (Fr.) Flörke Rare 8
Cladonia gracilis (L.) Willd. Common, 8 loc.
Cladonia macilenta Hoffm. 7, 10, 11, 17, 20
Cladonia merochlorophaea Asah. 6, 8, 15, 16, 21
Cladonia phyllophora Ehrh. ex Hoffm. 1, 7, 17, 25
Cladonia pleurota (Flörke) Schaer. Common, 9 loc.
Cladonia pyxidata (L.) Hoffm. 1, 12
Cladonia ramulosa (With.) Laund. Rare 25
Cladonia rei Schaer. 1, 17, 25
Cladonia scabriuscula (Del. in Duby) Leight. 11, 20, 21
Cladonia squamosa (Scop.) Hoffm. Common, 13 loc.
Cladonia subulata (L.) Web. ex Wigg. 7, 20
Cladonia sulphurina (Michaux) Fr. Rare 6
Cladonia symphycarpa (Ach.) Fr. 1, 17
Cladonia turgida Ehrh. ex Hoffm. Rare 11
Cladonia uncialis (L.) Web. ex Wigg. Common, 6 loc.
Cladonia verticillata (Hoffm.) Schaer. 1, 7, 11, 17, 25
Collema subflaccidum Degel. 2, 3, 4, 5, 9
Collema tenax (Sw.) Ach. Rare 20
Conotrema urceolatum (Ach.) Tuck. Common, 14 loc. More common east and south but not found in northern Wisconsin or Minnesota or Isle Royale.
Cyphelium tigillare (Ach.) Ach. Rare 11
Dimerella lutea (Dicks.) Trev. 8, 12, 18, 24, 25
Dimerella pineti (Schrad. ex Ach.) Vezda Rare 18
Diploschistes scruposus (Schreb.) Norm. Rare 18
Eopyrenula leucoplaca (Wallr.) R. Harris Rare 4
Evernia mesomorpha Nyl. Common, 19 loc.
Graphis scripta (L.) Ach. Common, 14 loc.
Gyalecta truncigena (Ach.) Hepp Rare 2
Haematomma elatinum (Ach.) Mass. Rare 6
Haematomma pustulatum Brodo & W. Culb. Common, 7 loc. Known from northern Minnesota and lower Michigan (Brodo & Culberson 1986).
Hypocenomyce anthracophila (Nyl.) James & G. Schneid. 6, 10, 11, 16, 17
Hypocenomyce friesii (Ach. in Lilj.) James & G. Schneid. 6, 10, 11, 16
Hypocenomyce scalaris (Ach. ex. Lilj.) Choisy Common, 7 loc.
Hypogymnia physodes (L.) Nyl. Common, 23 loc.
Hypogymnia tubulosa (Schaer.) Hav. 1, 6, 9, 18, 21
Icmadophila ericetorum (L.) Zahlbr. 8, 18

Imshaugia aleurites (Ach.) S. F. Meyer Common, 10 loc.
Imshaugia placorodia (Ach.) S. F. Meyer 1, 6, 11, 17
Julella fallaciosa (Stizenb. ex. Arn.) R. Harris 3, 5, 14, 19
Lecanactis chloroconia Tuck. 8, 9, 12, 21, 24
Lecanora allophana Nyl. 2, 3, 5, 14
Lecanora caesiorubella Ach. subsp. *caesiorubella* Common, 10 loc.
Lecanora carpinea (L.) Vain. 2, 3, 4, 19. Reported from the western United States and Lake Superior area by Imshaug & Brodo (1966).
Lecanora circumborealis Brodo & Vitik. 6, 8, 16
Lecanora hybocarpa (Tuck.) Brodo 4, 12.
Lecanora impudens Degel. 2, 5
Lecanora pallida (Schreb.) Rabenh. var. *pallida* Rare 9. In the Great Lakes area this was reported from the north shore of Lake Superior and from the Mackinac Straits (Imshaug & Brodo 1966).
Lecanora pallida var. *rubescens* Imsh. & Brodo Common, 9 loc.
Lecanora pulicaris (Pers.) Ach. Common, 7 loc.
Lecanora rugosella Zahlbr. 8, 21
Lecanora saligna (Schrad.) Zahlbr. Rare 25
Lecanora strobilina (Spreng.) Kieff. Rare 10
Lecanora symmicta (Ach.) Ach. Common, 10 loc.
Lecanora thysanophora R. Harris ined. Common, 13 loc.
Lecanora wisconsinensis Magn. Common, 12 loc.
Lecuidea albohyalina (Nyl.) Th. Fr. Rare 2
Lecidea caeca Lowe 1, 6
Lecidea elabens Fr. 6, 10, 11 16
Lecidea epixanthoidiza Nyl. Rare 18
Lecidea erratica Körb. Rare 22
Lecidea erythrophea Flörke ex Somm. 2, 19
Lecidea helvola (Körb. ex Hellb.) Oliv. 7, 8, 21
Lecidea hypnorum Lib. Rare 20
Lecidea nylanderi (Anzi) Th. Fr. 1, 6
Lecidea plebeja Nyl. 6, 10, 11, 17
Lecidea vernalis (L.) Ach. 21, 24
Lecidella euphorea (Flörke) Hert. 1, 4
Lecidella stigmatea (Ach.) Hert. & Leuck. Rare 20
Lepraria finkii (B. de Lesd. in Hue) R. Harris 18, 20
Leptogium cyanescens (Rabenh.) Körb. 9, 13, 23
Leptogium tenuissimum (Dicks.) Körb. 9, 13
Leptorhaphis epidermidis (Ach.) Th. Fr. 10, 16, 18, 19
Lobaria pulmonaria (L.) Hoffm. Common, 14 loc.
Lobaria quercizans Michaux Common, 9 loc.
Lopadium pezizoideum (Ach.) Körb. 18, 21, 23
Menegazzia terebrata (Hoffm.) Mass. Rare 18
Micarea denigrata (Fr.) Hedl. Rare 19. Also found in northern Minnesota.
Micarea melaena (Nyl.) Hedl. Common, 13 loc.
Micarea peliocarpa (Anzi) Coppins & R. Sant. 18, 21
Microcalicium disseminatum (Ach.) Vain. 8, 21. Also found in Isle Royale and Slate Islands, Ontario.
Mycoblastus sanguinarius (L.) Norm. Common, 7 loc.
Mycocalicium subtile (Pers.) Szat. 5, 19
Nephroma parile (Ach.) Ach. Rare 23
Ochrolechia arborea (Kreyer) Almb. Common, 9 loc.
Orchrolechia pseudopallescens Brodo ined. 17, 21, 23. Common in northern Minnesota.
Ochrolechia rosella (Müll. Arg.) Vers. 2, 7, 22
Opegrapha niveoatra (Borr.) Laund. Rare 21. Also found on Isle Royale.
Opegrapha varia Pers. Rare 3
Pachyospora verrucosa (Ach.) Mass. 3, 14
Parmelia aurulenta Tuck. Common, 9 loc.
Parmelia caperata (L.) Ach. Common, 20 loc.
Parmelia crinita Ach. Common, 7 loc.
Parmelia exasperatula Nyl. 1, 2, 4
Parmelia galbina Ach. 4, 5, 7, 12, 15
Parmelia olivacea (L.) Ach. 4, 7, 10
Parmelia rudecta Ach. Common, 23 loc.
Parmelia septentrionalis (Lynge) Ahti Common, 6 loc.
Parmelia squarrosa Hale Common, 10 loc.
Parmelia subargentifera Nyl. 3, 14
Parmelia subaurifera Nyl. Common, 25 loc.
Parmelia subolivacea Nyl. in Hasse Rare 7
Parmelia subrudecta Nyl. Common, 10 loc.
Parmelia sulcata Tayl. Common, 22 loc.
Parmeliopsis ambigua (Wulf. in Jacq.) Nyl. Common, 9 loc.
Parmeliopsis hyperopta (Ach.) Arn. Common, 6 loc.

Peltigera canina (L.) Willd. Common, 7 loc.
Peltigera didacytla (With.) Laund. 12, 17, 19
Peltigera elisabethae Gyeln. 4, 12, 13, 15, 18
Peltigera evansiana Gyeln. Common, 7 loc.
Peltigera horizontalis (Huds.) Baumg. Rare 9
Peltigera neckeri Hepp ex Müll. Arg. 1, 4
Peltigera polydactyla (Neck.) Hoffm. Common, 7 loc.
Peltigera praetextata (Flörke ex Somm.) Zopf 3, 25
Peltigera rufescens (Weis) Humb. Rare 1
Pertusaria alpina Hepp ex Ahles 2, 5
Pertusaria amara (Ach.) Nyl. Common, 18 loc.
Pertusaria consocians Dibb. 21, 22
Pertusaria macounii (Lamb) Dibb. 3, 5, 15, 19, 23
Pertusaria multipunctoides Dibb. Rare 8
Pertusaria ophthalmiza (Nyl.) Nyl. Common, 6 loc.
Pertusaria rubefacta Erichs. Rare 23
Pertusaria trachythallina Erichs. 3, 7, 22
Pertusaria velata (Turn.) Nyl. Common, 7 loc.
Pertusaria waghornei Hult. Rare 23
Phaeocalicium populneum (Brond. ex Duby) Schmidt Rare 1
Phaeophyscia chloantha (Ach.) Moberg Rare 4
Phaeophyscia imbricata (Vain.) Essl. Rare 3
Phaeophysica orbicularis (Neck.) Moberg Rare 20
Phaeophyscia pusilloides (Zahlbr.) Essl. Common, 9 loc.
Phaeophyscia rubropulchra (Degel.) Moberg Common, 14 loc.
Phlyctis argena (Spreng.) Flot. 5, 12, 18
Physcia adscendens (Th. Fr.) Oliv. Common, 9 loc.
Physcia aipolia (Ehrh. ex Humb.) Fürnr. Common, 10 loc.
Physcia stellaris (L.) Nyl. 11, 20
Physconia detersa (Nyl.) Poelt Common, 13 loc.
Placynthiella icmalea (Ach.) Coppins & James 9, 10, 17
Placynthiella oligotropha (Laund.) Coppins & James 10, 11, 16, 17, 25
Plagiocarpa hyalospora (Nyl.) R. Harris 9, 13. Reported from eastern North America west to Michigan but not known from Minnesota (Harris 1973).
Platismatia tuckermanii (Oakes) W. Culb. & C. Culb. 1, 6, 8, 17, 21
Porpidia albocaerulescens (Wulf.) Hert. & Knoph Rare 13
Porpidia macrocarpa (DC. in Lam. & DC.) Hert. & Schwab 20, 22, 25. Some of the material included here may be moved to other species according to the recent revision of the genus (Gowan 1989).
Pseudevernia consocians (Vain.) Hale & W. Culb. Common, 7 loc.
Pyrenula pseudobufonia (Rehm) R. Harris Rare 5
Pyxine sorediata (Ach.) Mont. Common, 6 loc.
Ramalina americana Hale Common, 11 loc.
Ramalina dilacerata (Hoffm.) Hoffm. Rare 15
Ramalina intermedia (Del. ex Nyl.) Nyl. Common, 12 loc.
Ramalina pollinaria (Westr.) Ach. Rare 15. Also known from Isle Royale and northern Michigan.
Rinodina ascociscana Tuck. 5, 14, Known from northern Michigan and northern Wisconsin but not Minnesota.
Rinodina subminuta Magn. Common, 6 loc.
Scoliciosporum chlorococcum (Graewe ex Stenh.) Vezda Common, 10 loc.
Sphinctrina turbinata (Pers.) De Not. 19, 22, 23
Stenocybe major Nyl. ex Körb. 8, 12, 15, 24
Stenocybe pullatula (Ach.) B. Stein 13, 24
Strigula stigmatella (Ach.) R. Harris 9, 12, 18, 24
Trapelia involuta (Tayl.) Hert. Rare 25
Trapeliopsis flexuosa (Fr.) Coppins & James Rare 25
Trapeliopsis granulosa (Ehrh.) Lumbsch Common, 8 loc.
Trapeliopsis viridescens (Schrad.) Coppins & James 9, 15, 24, 25
Usnea cavernosa Tuck. 8, 12, 18
Usnea ceratina Ach. Rare 9
Usnea filipendula Stirt. Rare 8
Usnea hirta (L.) Weber ex. Wigg. Common, 10 loc.
Usnea subfloridana Stirt. Common, 17 loc.
Verrucaria muralis Ach. 12, 17
Xanthoria polycarpa (Hoffm.) Rieber Common, 6 loc.
Xylographa disseminata Will. Rare 16. Probably the first record for the Great Lakes region.

DISCUSSION OF FLORA

In addition to this list of 235 taxa there are 9 unidentified species, some of which may be undescribed. The most common species are *Cladina rangiferina*, *Cladonia coniocraea*, *Hypogymnia physodes*, *Parmelia caperata*, *P. subaurifera*, *Phaeophyscia rubropulchra* and *Usnea subfloridana*. *Lobaria pulmonaria* and *L. quercizans* are not uncommon in the hardwood forests.

The lack of rocks limits the number of species in the park. Some lichens were found on pebbles but hardly any were found on the soft sandstone along the shores. Some of the lakeshore areas have good lichen floras and the open sand plains are rich in lichens but the shady hardwood forests have fewer species. The lake influence on the lichen flora is very obvious along most of the shore and many northern species are found only in a narrow zone near Lake Superior.

The locality with the greatest number of species collected only once in the whole park is south of Miners Falls in a *Thuja* bog. These bogs are always rich in lichen species. It is not known why this bog has more rare species than the other similar bogs in the park. The second highest number was at Munising Falls and at the north side of Grand Sable Lake. At Munising Falls, the rock outcrops added a rare substrate and several of the rare species were found on the rocks. At Grand Sable Lake, the open jack pines and bare soil provided many good habitats for lichens.

Some of the species found only once are rare wherever they are found throughout their distributional range and might be found at other localities with further searching while others may require special substrates that are rare in the park.

ACKNOWLEDGEMENTS

This study originated as an air quality project funded by the National Park Service and this paper is the floristic part of that report (Wetmore 1988). The park personnel have been very helpful during the field work which has contributed significantly to the success of the projects. Dr. James Bennett provided suggestions on the field work and the manuscript. The assistance of all of these is gratefully acknowledged.

COLLECTION LOCALITIES

The following is a list of collection localities for this study. The number at the beginning of each locality is cited in the species list. All collections are from Alger County, Michigan.

1. North side of Grand Sable Lake, 2 miles west of Grand Marais. On ridges with jack pines and openings. Sec. 10, T49N, R14W. 10 July 1987.
2. South of Grand Sable Dunes, 4 miles west-southwest of Grand Marais. In maple-beech forest with some old balsam fir. Sec. 16, T49N, R14W. 10 July 1987.
3. West of the log slide on shore of Lake Superior (6 miles west of Grand Marais). Maple-beech forest at edge of bluffs with some balsam poplar and birch. Sec. 12, T49N, R15W. 10 July 1987.
4. At mouth of Sable Creek, 1.5 miles west of Grand Marais. Along lowland near shore with balsam fir, maple and some balsam poplar. Sec. 2, T49N, R14W. 11 July 1987.
5. East side of Grand Sable Lake, 0.5 mile south of boat landing. Maple-beech woods with wet area with black ash. Sec. 14, T49N, R14W. 11 July 1987.
6. 0.5 mile south of Twelvemile Beach Campground. In jack pine forest near junction of campground road and highway 58. Sec. 17, T49N, R15W. 13 July 1987.

7. Twelvemile Beach, 1 mile northeast of Twelvemile Beach Campground. Along shore in mixed forest of white pine, white birch, balsam fir and maple. Sec. 16, T49N, R15W. 13 July 1987.
8. Au Sable Point. In edge of swamp behind point with balsam fir, *Thuja*, some white birch and hemlock. Sec. 2, T49N, R15W. 13 July 1987.
9. Around mouth of Sevenmile Creek at Twelvemile Beach. Along stream with *Thuja*, balsam fir, white birch and maple. Sec. 25, T49N, R16W. 14 July 1987.
10. 1.5 miles southwest of Twelvemile Beach Campground along Lake Superior. In open white birch forest near shore with pine stumps. Sec. 19, T49N, R15W. 14 July 1987.
11. 1 mile north of Kingston Lake just outside Pictured Rocks NL. In pine barrens with jack pine, stumps and open sandy areas. Sec. 32, T49N, R15W. 15 July 1987.
12. 0.5 mile southwest of Hurricane River Campground. Back from shore of Lake Superior in low area with *Thuja*, balsam fir, maple and white birch. Sec. 10, T49N, R15W. 15 July 1987.
13. South of Beaver Lake along Lowney Creek. Along stream and edge of bog with *Thuja* and alder. Sec. 17, T48N, R16W. 16 July 1987.
14. South of Beaver Lake at end of road on ridgetop. In maple forest east of road. Sec. 15, T48N, R16W. 16 July 1987.
15. West of Beaver Lake near shore of Lake Superior. On cliffs in hemlock, yellow birch and red maple forest. Sec. 12, T48N, R17W. 17 July 1987.
16. Northwest of Beaver Lake on ridge south of Lake Superior. Pine forest with openings, red pine, spruce and white birch. Sec. 7, T48N, R16W. 17July 1987.
17. 1 mile east of Miners Castle Point near shore of Lake Superior. In jack pine woods with some red pines and open areas. Sec. 3, T47N, R18W. 18 July 1987.
18. Just south of Miners Falls. In *Thuga* bog with stream and some tamarack. Sec. 15, T47N, R18W. 18 July 1987.
19. 0.5 mile south-southwest of Miners Castle Point. On upland in open beech-maple forest. Sec. 9, T47N, R18W. 18 July 1987.
20. Munising Falls at eastern edge of Munising. Along stream and cliffs with mixed hardwoods and conifers. Sec. 36, T47N, R18W. 19 July 1987.
21. Sand Point, 2 miles northeast of Munising. In swamp at north side of point with *Thuja*, black spruce and balsam fir. Sec. 19, T47N, R18W. 19 July 1987.
22. Along shore of Lake Superior, 1 mile east of mouth of Chapel River. On cliffs with red maple, yellow birch and some spruce. Sec. 15, T48N, R17W. 20 July 1987.
23. Grand Portal Point. On points on east side with hemlock, white pine, yellow birch and some *Thuja*. Sec. 17, T48N, R17W. 20 July 1987.
24. Near shore of Lake Superior along Mosquito River. In mixed woods along stream with hemlock, birch, maple, balsam fir and *Thuja*. Sec. 25, T48N, R18W. 21 July 1987.
25. 2 miles south of Grand Portal Point at junction of trails to Chapel Lake and Mosquito Beach. On hillside and open area with red maples and some conifers. Sec. 29, T48N, R17W. 21 July 1987.

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NOTEWORTHY COLLECTIONS

MICHIGAN

FUNARIA FLAVICANS Michaux. (Funariaceae)

Previous knowledge. Funaria flavicans, like other members of the family, is a weedy moss. It has a broad distribution in the eastern United States, but it is essentially southern, though extending northward in its range to New York, Ohio, and Indiana (Crum & Anderson 1981). Its range is, in fact, not unlike that of *Cornus florida* and *Cercis canadensis,* which reach their northern limits in southern Michigan. The species was found not long ago at Pelee Point in Essex County, Ontario (Crum & Botham 1968), and so its occurrence in southern Michigan is not entirely unexpected.

Significance. The species has not been recorded previously for the state of Michigan.

Diagnostic characters. Funaria flavicans differs from the cosmopolitan *F. hygrometrica* Hedw. in having non-hygroscopic setae and nearly straight, lightly plicate capsules with inner peristome segments only about one-third the length of the teeth, or less, and bilobed at the apex.

WASHTENAW CO.: Superior Township, SW 1/4 sec. 22, T2S, R7E, *Ruth B. Alford 3367,* 4 June 1974 (EMC). The plants grew at the edge of railroad tracks behind the Superior power station on dry rocks and cinders in full sun.

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AGALINIS GATTINGERI (Small) Small. (*Gerardia gattingeri* Small) (Scophulariaceae) Gattinger's Purple False Foxglove.

Previous knowledge. In Michigan this species has been collected in Oakland Co. (*Farwell* 3860, BLH in 1914), Monroe Co. (*Chandler*, WUD in 1915), and Kalamazoo Co., (*Hanes & Hanes* 2805, MICH in 1935). There are extant populations adjacent to Michigan on Squirrel Island and Walpole Island, on the Ontario side of Lake St. Clair (Canne-Hilliker 1987).

Significance. This is apparently the first record of *Agalinis gattingeri* in Michigan in 53 years. The center of distribution of this prairie species is Missouri, where it has been recorded in about 60 counties (Steyermark 1963). It is also widespread in Illinois, where it has been collected in about 20 counties (Jones & Fuller 1955). Elsewhere Pennell (1929, 1935) and Canne-Hilliker (1987) have reported it from Alabama, Arkansas, Indiana, Iowa, Kansas, Louisiana, Minnesota (extant in Winona Co.), Mississippi, Nebraska, Ohio (a 1929 record from Delaware Co.), Oklahoma, Tennessee, Texas, and Wisconsin (extant in Sauk Co.). It has also been recorded from 2 counties in Ontario: Lambton Co. (where extant) and Brant Co. (a 1952 record). *Agalinis gattingeri* is listed as Probably Extirpated in Michigan (Beaman et al. 1985), Threatened in Minnesota (Coffin & Pfanmuller 1988), and Rare in Ontario (Argus & White 1983). It is presumed extirpated in Ohio (Bentz & Cooperrider 1978, p. 153).

Diagnostic characters. This species is closely related to *Agalinis skinneriana*. Canne-Hilliker (1987), who studied both of these species in the field and laboratory, listed several morphological features that, taken together, serve to distinguish them throughout their ranges. *A. gattingeri* differs from *A. skinneriana* in having 1) corollas that are medium pink with many red spots and a pair of yellow lines on the lower lip (vs. corollas that are very pale pink to white, with barely discernible or no spots and lines); 2) lower corolla lobes pilose externally (vs. lower lobes glabrous); 3) leaves 1.0–3.4 cm long and spreading to ascending (vs. leaves 0.5–2.0 cm and nearly erect); 4) pedicels 0.4–3.0 cm long, and 1.5 to 4 times as long as the subtending bract (vs. pedicels 0.4–1.7 cm, and 1 or 2 times as long as the subtending bract); 5) upper stem ridges lacking fiber bundles (vs. upper stem ridges containing fiber bundles visible in cross-section with a hand lens). In addition, *A. gattingeri* generally has branches which are more numerous and less strongly ascending than those of *A. skinneriana*. Pennell (1935) indicated that *A. gattingeri* flowers somewhat later than *A. skinneriana*: late August to mid-October versus mid-August to early September. This may hold true in St. Clair Co., where *A. gattingeri* was still in bloom in early October when all plants of *A. skinneriana* were in fruit. *Agalinis tenuifolia*, which shares with *A. gattingeri* and *A. skinneriana* the character of elongate pedicels, can be distinguished by its upper corolla lobes, which are forward-projecting rather than recurved. Also, *A. tenuifolia* has a pinkish-purple corolla and darker green foilage.

MICHIGAN. ST. CLAIR CO.: north of Algonac, 6 October 1988, *Brodowicz* (MICH). On moist circumneutral sand in an area of abandoned borrow pits. Uncommon. Occurring with *Agalinis skinneriana*, *Aristida longispica*, *Aristida necopina*, *Hemicarpha micrantha*, *Hypericum gentianoides*, *Juncus brachycarpus*, *Ludwigia alternifolia*, *Scleria triglomerata*, and *Spiranthes ochroleuca*.

Most of these associates are species of prairie affinities, and are quite uncommon in the Great Lakes region. The fact that C. K. Dodge collected many of them in the same area nearly a century ago illustrates the ability of this flora to persist locally.

Canne-Hilliker (1987) noted that populations of *A. gattingeri* vary in size from year to year at any given locality. Because the plants are delicate annuals renewal of populations yearly is dependent on seeds previously produced. Unfavorable conditions for germination or for seedling growth and survival could restrict population size markedly during any one season.

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AGALINIS SKINNERIANA (A. Wood) Britton. (*Gerardia skinneriana* Wood) (Scrophulariaceae) Skinner's Purple False Foxglove.

Previous knowledge. There apparently have been no previous collections of this prairie species in Michigan. However, it has long been known from areas adjacent to Michigan in northwestern Indiana, northern Ohio, and southwestern Ontario.

Significance. This collection documents the occurrence of *Agalinis skinneriana* in Michigan. This species is rare throughout its range. Pennell (1929, 1935) and Canne-Hilliker (1987) have recorded it from Arkansas (1 county), Indiana (2 counties), Iowa (4 counties), eastern Kansas (8 counties), Louisiana (a few parishes), southeastern Minnesota (1 county), Missouri (12 counties), Ohio (4 counties), Oklahoma (1 county), and Wisconsin (3 counties). Brown and Brown (1984) reported it from Maryland, stating that it is "*little known.*" In Ontario, there are extant populations near the

Detroit River at Lasalle in Essex County, and in Lambton Co. on two islands in Lake St. Clair (Squirrel Island and Walpole Island) (Canné-Hilliker 1987). *A. skinneriana* is listed as Threatened in Ohio (McCance et al. 1982–1987), and Rare in Ontario (Argus & White 1983). Pennell, the monographer of the genus, considered it one of the rarest of *Agalinis* species. He noted that "it is one of the very few species of *Agalinis* that I have not succeeded in finding in the field, even though I have made a special search for it. Even more surely than *A. acuta*, it is a waning species, but why it has become so restricted seems more difficult to explain" (Pennell 1929, p. 127).

MICHIGAN. ST. CLAIR CO.: north of Algonac, 10 September 1988, *Brodowicz, Albert, Chittenden, & Penskar* (MICH). Local; sometimes in thick colonies of dozens of plants. Occurring with *Agalinis gattingeri, Aristida longispica, Aristida necopina, Hemicarpha micrantha, Hypericum gentianoides, Juncus brachycarpus, Ludwigia alternifolia, Scleria triglomerata*, and *Spiranthes ochroleuca*.

Although *A. skinneriana* and *A. gattingeri* are similar morphologically and share the same chromosome number (Canne 1984), and have lived in proximity in the Algonac area for many decades, no evidence of hybridization has been found (Canne-Hilliker 1987).

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AMPELOPSIS BREVIPEDUNCULATA (Maxim.) Trautv. (Vitaceae) Porcelain Vine.

Previous knowledge. This Asian vine was reported in *Gray's Manual* to be naturalized from New England to Ohio and southward.

Significance. This is apparently the first Michigan collection of naturalized plants of this species.

Diagnostic characters. Ampelopsis brevipedunculata closely resembles species of *Vitis*. It differs from *Vitis* in having stems with white pith and tight bark (vs. stems with brown pith and exfoliating bark), petals that

completely separate from each other (vs. petals that remain joined above), and a dichotomously forking cyme (vs. a compact panicle).

MICHIGAN. WAYNE CO.: Detroit, River Rouge Park north of Joy Road, August 1988, *Brodowicz & Penskar* (MICH). Locally frequent in the floodplain of the River Rouge, climbing over shrubs along the wooded edge of the river. The population extended about 200 meters. Soil pH was 7.8. A common associate was *Vitis riparia*. The presence of occasional seedlings confirmed that the species was naturalized.

This species has attractive berries in various shades of blue which ripen in September. They are likely dispersed by birds.

SCIRPUS HALLII A. Gray. (*Schoenoplectus erectus* (Poir.) Palla, *Scirpus supinus* var. *hallii* (A. Gray) A. Gray) (Cyperaceae).

Previous knowledge. The first Michigan collection of this species was in 1900 in Muskegon Co., probably at Carr Lake (see Voss 1967). It was rediscovered at Carr Lake in 1959 (*Voss* 9152, MICH) and continues to persist in this area (*Reznicek* 7793 in 1986, MICH). In 1986 a second population was discovered at Pine Island Lake, also in Muskegon Co., about 11 miles north of Carr Lake (Reznicek 7790, MICH).

Significance. The present collection documents a third population of *Scirpus hallii* in Michigan. This species has a very disjunct distribution in North America and is quite rare. Outside of Florida it is known from only a few records including 1 in Massachusetts, 1 in Illinois, 1 in Missouri, 1 in South Carolina, and 1 in Oregon. It has also been recorded from Nebraska and Kansas (McGregor et al. 1986), and Georgia. In Michigan this species is listed as Endangered (Beaman et al. 1985).

Diagnostic characters. Scirpus hallii can be distinguished from its close relative of the Great Plains, *S. saximontanus*, by achenes which are 2-styled and lenticular rather than 3-styled and trigonous. In both species the achenes are transversely rugose and there are usually no perianth bristles.

MICHIGAN. MUSKEGON CO.: north of Pine Island Lake; T12N, R15W, Sect. 19; 16 August 1988, *Brodowicz & Reese* (MICH). Locally common (hundreds of plants) on the exposed south facing bank of a sandy depression that in a wetter year would have still held water. Many of the plants had mature achenes. Occurring with *Cyperus rivularis*, *Fimbristylis autumnalis*, *Hypericum canadense*, *Panicum rigidulum*, *Rotala ramosior*, *Stachys hyssopifolia*, and *Viola lanceolata*. The land is part of the Huron-Manistee National Forest.

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SCLERIA PAUCIFLORA Muhlenb. ex Willd. (Cyperaceae).

Previous knowledge. In Michigan this species has been collected in St.

Clair Co. (*W. S. Cooper*, MSC, in 1903), Van Buren Co. (*H. S. Pepoon* 92, MSC, in 1904), and Oakland Co. (3 collections from a site in Royal Oak in 1920: *B. A. Walpole* 837 (BLH), *C. Billington* (MICH), and *O. A. Farwell* 5579 (MICH). All three counties are in the southern part of the state.

Significance. This collection documents the occurrence of *Scleria pauciflora* in Muskegon Co., and is the first record of this species in Michigan in 68 years. The species ranges from Connecticut to Michigan and Kansas, and south into Mexico. It is much more frequent in the South. It has been collected in 3 counties of northwestern Indiana (Deam 1940), and seven counties of Ohio (McCance et al. 1982–1987). It is listed as Probably Extirpated in Michigan (Beaman et al. 1985), and Threatened in Ohio (McCance et al. 1982–87).

Diagnostic characters. This species can be distinguished by the presence of 6 tubercles at the base of each papillose achene. It is a perennial with a short, rather stout rhizome. The plants in Muskegon County, like those of the previous Michigan collections, and those of Indiana, and some of the Ohio collections are var. *caroliniana* (Willd.) Wood. This variety ranges farther north than var. *pauciflora*, and is less common in the Gulf States (Fairey 1967). It is characterized by dense pubescence on the leaves and stems.

MICHIGAN. MUSKEGON CO.: north of Pine Island Lake; T12N, R15W, Sect. 19; 16 August 1988, *Brodowicz & Reese* (MICH). Very local, a small colony on dry sand beside a moist depression. Occurring with *Rhynchospora capitellata*, *Xyris torta*, *Polytrichum*, and lichens. Mature achenes were present. The land is part of the Huron-Manistee National Forest.

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CATASCOPIUM NIGRITUM (Hedw.) Brid. (Catascopiaceae).

Previous knowledge. Previous Michigan collections of this circumboreal moss have been from the Straits of Mackinac region (Cheboygan, Emmet, Mackinac, and Presque Isle counties) (Crum 1983).

Significance. This collection documents the occurrence of *Catascopium nigritum* nearly 200 miles south of its previously known stations in Michigan.

MICHIGAN. OAKLAND CO.: south of Rattalee Lake, east side of Shiawassee River; T4N, R7E, Sect. 1; *Brodowicz* (MICH). Specimen determined by Howard Crum. Occurring around marly springs with other boreal calciphiles which are uncommon in southern Michigan, including the moss *Scorpidium scorpioides*, and the grasses *Calamagrostis inexpansa* and *Deschampsia cespitosa*.

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MICROMITRIUM MEGALOSPORUM Aust. (Ephemeraceae).

Previous knowledge. This minute moss has apparently not been previously collected outside of the Atlantic and Gulf coastal plains and Cuba (Crum & Anderson 1981).

Significance. Micromitrium megalosporum ranges from coastal Maine to Florida and Cuba. It also occurs in Louisiana. The Michigan collections represent a major disjunction from the Coastal Plain. Significantly, the Michigan pond-shores where this moss occurs are noted for the large number of disjunct Coastal Plain vascular plants that they host. This moss, like the vascular plants, was most likely introduced long ago by migratory waterfowl or shorebirds returning in the spring from the Coastal Plain ponds where they pass the winter (see deVlaming & Proctor 1968; Proctor 1961).

Diagnostic characters. This species can readily be distinguished from the other 3 North American species of *Micromitrium* by 1) capsule walls with stomata present and no regular line of dehiscence; 2) very large spores mostly 65 μm in diameter. The globose capsule nestled in the leaves reminded Grout (1933) of "*a nest containing one egg.*"

MICHIGAN. ALLEGAN CO.: southwest side of Crooked Lake; T2N, R15W, Sect. 25; 30 September 1988, *Brodowicz & Penskar* (MICH). On moist organic-sandy shore. Occurring with *Fossombronia cristula* and *Riccia sullivantii.* VAN BUREN CO.: northwest side of Knickerbocker Lake; T4S, R15W, Sect. 21; 30 September 1988, *Brodowicz & Penskar* (MICH). On moist organic-sandy shore. Occurring with *Fossombronia cristula.* DELTA CO.: on south shore of Wolf Lake; T42N, R18W, Sect. 11. On moist organic-sandy shore. Found by *Norton Miller* (MICH) in a specimen of *Fossombronia cristula* collected by M. Penskar in August 1988.

The pond-shores where this moss occurred were exceptionally broad in 1988 owing to a prolonged drought. In Florida (where this species is frequent) it similarly occurs "around the edges of partially dried pools" (Grout 1933).

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RICCIA SULLIVANTII Aust. (Ricciaceae).

Previous knowledge. The only previous Michigan collections of this

liverwort were made in November 1981 in Monroe and Washtenaw counties in the southeastern part of the state (Mayfield et al. 1983).

Significance. The two present collections document the occurrence of *Riccia sullivantii* in southwestern and central Michigan.

MICHIGAN. ALLEGAN CO.: southwest shore of Crooked Lake; T2N, R15W, Sect. 25; 30 September 1988, *Brodowicz & Penskar* (MICH). Local; occupying an area less than 2 meters in diameter on a moist organic-sandy shore. Occurring with *Fossombronia cristula*, *Micromitrium megalosporum*, and a number of disjunct Coastal Plain vascular plants. The shore had been broadly exposed by the prolonged drought of 1988. GRATIOT CO.: in a swale between low sand ridges in the Gratiot-Saginaw State Game Area, 30 October 1988, *Albert* (MICH). Occurring with *Ephemerum crassinervium*.

The spores of this species are probably introduced into ponds by waterfowl (see Proctor 1961; Schuster 1966, p. 177).

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√ REVIEW

MANUAL OF THE SEED PLANTS OF INDIANA. By William B. Crankshaw. Indiana Academy of Science, Indiana State Library, 140 N. Senate Ave., Indianapolis 46204. 1989. 278 pp. $12.00 posptaid [sic], paperbound.

That whirring noise you hear in the background is Charles C. Deam turning in his grave. To learn about the plants of Indiana, you would do far better to buy the facsimile reprint of Deam's *Flora of Indiana,* even though that is now 50 years old, than to invest in the present volume. The author frankly admits that he is an ecologist, not a taxonomist (neither was Deam!), but that does not excuse the abundant internal contradictions and apparent lack of understanding of how keys work. Nor does it excuse the erroneous description, in the first paragraph of the Introduction, of *Arctostaphylos uva-ursi* as a Tundra plant in contrast to Boreal Forest species like *Larix laricina*—when both have essentially the same northern border in North America, the Larix in fact ranging a little farther north.

In the Introduction, the author defends use of the Englerian system on the grounds of familiarity. But in fact there is no trace of the Englerian system, the families being strictly alphabetical. Furthermore, the Introduction cites the 1983 Crovello, Keller, and Kartesz checklist for Indiana, which "notes recent additions to the state flora," but fails to mention that the additions since 1940 are apparently not thought worthy of inclusion in the new manual. The Introduction is too brief (4 pages) as well as too untrustworthy to be useful.

The bulk of the manual is a set of simple keys, in a format deadly to the eyes. A straightedge will help readers line up a number at the right margin with a lead of as few as 1–3 words far to the left. Couplet 1 in the key to families is "Tree or shrub with needle-like or scale-like leaves; ovules not in an enclused [sic] ovary (Gymnosperms)" vs. "Herbaceous or woody plant; broad or narrow leaves, not needle-like; ovule within a closed ovary which at maturity becomes the fruit (Angiosperms)." Pity the poor beginner who looks in the glossary, to find that ovules are found "within an ovary" [apparently not in gymnosperms at all!], that "needle-like" is not defined [though it apparently includes "flat" and "blunt" leaves (cf. *Taxus, Taxodium,* p. 210) but not "thread-like" ones as in *Asparagus* and *Euphorbia cyparissias*], and that the angiospermous *Hudsonia* has "scale-like" leaves (p. 38). Couplet 5 will eliminate Lemnaceae ("Plant without true leaves or stems; floating acquatic [sic]") and a collector with, say, coontail (*Ceratophyllum*) is to assume it is "not floating" and move to couplet 6, where monocots and dicots are distinguished by the venation "usually" seen [not very helpful with *Linum* and other 1-veined plants, nor with leafless autotrophs], number of flowering parts [no exceptions allowed to 4's and 5's for dicots, so forget about *Euphorbia, Floerkea,* etc.], and less ambiguous but very difficult characters of vascular tissue and number of cotyledons. Assuming the novice with his *Ceratophyllum* (almost never seen to flower) gets past this point, he will run it quickly to the Urticaceae (nettles), or else he must lie twice and say (29) "Flowers with either petals or sepals or both"

and (53) "Leaves not whorled"; count the ovules and pistils; and cross other hurdles before deciding that the leaves after all *are* whorled (71) and reading in the text (p. 30) that sepals and petals are absent. For a plant whose whorled dichotomously forked leaves are so distinctive that it can be identified vegetatively from several feet away, that is quite an ordeal!

To key down *Cannabis* or *Humulus* (treated as herbaceous Moraceae), one has to select "Herb" at 66, but 66 is reached only by saying "Woody plant" at 60. Internal contradictions such as these (requiring one to make a decision and then later to deny it) abound in the keys, rendering them useless and frustrating to students. Then there are nonsense choices like couplet 9: "Sepals and/or petals lacking" vs. "Sepals and/or petals present." Plants with neither sepals nor petals can go under the first choice, and those with both under the second. Monocots with a single perianth series will fit either. (No, Juncaceae will *not* key under the second choice, but only under the first, where one also has to say their flowers are "in flat-topped clusters" and that the carpels do not separate at maturity, leaving us to imagine how the seeds escape.) Cyperaceae are said to couplet 8 to have "Stems triangular in cross-section and solid" although *Dulichium* is admitted on p. 94 to have hollow, terete stems and *Eleocharis* on the next page to have usually terete stems (as do many *Scirpus).*

I omit comments on over 200 additional pages of keys that don't turn. There are often a few words of habitat and occasionally of range in the keys to species. There is a large glossary, not too badly done, although defining sessile merely as "stemless" is not very helpful when stems are nowhere defined (though leaves, flowers, and inflorescences are all said to have them) and one wonders what would be meant by a stemless [i.e., sessile?] violet. Leaf scars are said to be made by petioles; evidently sessile leaves make no scars. "Smooth" should perhaps have been defined [incorrectly] as glabrous (hairless) so that someone having trouble keying *Panicum verrucosum* on p. 136 might not think it contradictory to say "Spikelets smooth" and then shortly "Spikelets warty."

A set of easy field keys can be useful to beginners, as long demonstrated by Gleason's excellent *Plants of Michigan*. The present keys make me think of a giant maze, however, whose designer provided no exit. They are unworkable because of errors of fact, errors of construction, and reliance ultimately on obscure anatomical characters—as well as frequent requirement to flip coins on choices like "tree" vs. "shrub." (The *only* way given to tell *Betula pumila* from *Alnus* is that the former is a "tree" and the latter—usually in fact much taller—is a "shrub.") It is also often necessary to camp by a plant all season long in order to obtain first the flowers, then the leaves, and later the fruit, all of which one needs to move through the keys.

The Indiana Academy of Sciences deserves credit for charging so low a price, but even that is too high for such a slovenly piece of work.

— EDWARD G. VOSS
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[Ed. note: This book has been withdrawn by the publisher.]

√ REVIEW

RODALE'S ILLUSTRATED ENCYCLOPEDIA OF HERBS. By Claire Kowalchik and William H. Hylton, editors. Rodale Press. Emmaus, PA. 1987. 545 pp. $24.95.

This herbal encyclopedia has all of the appropriate assets of the layman's over-the-counter coffee-table book: slick pages, something eye-catching on almost every page (chart, photo, illustration, side-bar information), idealized herbal plans for layouts of Benedictine monasteries, and color photos of flowers of unrelated species (such as yarrow, goldenseal, and borage).

The formula of presentation is consistent in spite of the busy, busy, busy aspect of the pages. Genus, species, family names are followed by a short history of the plant's uses both in folklore and in history (some quite interesting), uses in modern medicine, plant description, flowering times, range, growing conditions, plus cultivation and "chef tips."

Readers with any botanical background will feel uneasy about identification methods. There is not reliable way either by photo, illustration, or description to identify the majority of the plants. The descriptions could often fit a variety of plants, the illustrations are "artsy flowery," and the photos usually show only the flower.

Disclaimers for the herb's effectiveness are frequently mentioned: "(w)hen it comes to treating an organ as vital as the heart, of course, self-medication is foolish, no matter how safe the herbal remedy," and the book's initial disclaimer: "(T)his book is intended as a reference volume only, not as a medical manual or a guide to self-treatment." It strongly suggests obtaining competent professional assistance.

Contents of the books are listed alphabetically, combining the common names with topics such as "dyes from herbs" and "companion planting." Herbs covered range from those locally available in Michigan to those found throughout the world, including those used in Arabic and North African cooking. Three pages of bibliography lean towards the herbal/horticulture/cosmetic orientation, although the competent *American Medical Association's Handbook of Poisonous and Injurious Plants* is included, as is Fernald's *Gray's Manual of Botany*. Twenty-eight newsletters and periodicals are listed with addresses, all of which deal with some aspect of the herbal world. A twenty-page index makes the plants, the remedies, the sources, the diseases, and the symptoms easy to access.

If you already know the plant's identification (your own I.D. or a reliable nursery source), there is much folklore and sometimes even some science crammed into this lavish presentation.

—Ellen Elliott Weatherbee
Matthaei Botanical Gardens
University of Michigan
Ann Arbor, MI 48109-1057

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EDITORIAL NOTICE: A NOTICE TO CONTRIBUTORS

Barbara Dyko has resigned as Co-editor of *The Michigan Botanist,* her current obligations taking all of the time that she formerly devoted to *The Botanist.* I thank her for all of her efforts on getting Volume 28 into the hands of our subscribers.

Dr. Gary Hannan is the new Co-editor. Gary is a plant systematist and a member of the Biology faculty at Eastern Michigan University. Please follow the *Information for Authors* that appeared in January, 1989 (Vol. 28(1): 43–46) when preparing manuscripts. All correspondence to the editors should be addressed as follows:

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— Richard K. Rabeler

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On the cover: A snow-covered road near Fleming Creek, Matthaei Botanical Gardens, Ann Arbor.
Photographed by Donald R. Farrar, Winter 1967–1968.

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THE MICHIGAN BOTANIST

March, 1990

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Articles dealing with any phase of botany relating to the Great Lakes Region may be sent to the Co-editors. In preparing manuscripts, authors are requested to follow our style and the suggestions in "Information for Authors" (Vol. 28, p.43).

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Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora; establishment suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

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HYBRIDS AMONG THREE CAULESCENT VIOLETS, WITH SPECIAL REFERENCE TO MICHIGAN

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INTRODUCTION

The caulescent, or "stemmed," blue-flowered and cream-flowered violets of the "Rostratae" group of subsection *Rostellatae* Boiss. in section *Nomimium* Ging. (Clausen 1929), comprise perhaps the least taxonomically complex group in eastern North America *Viola*. In our region, the taxa are well marked and widely distributed. Recent taxonomic investigations have led the author to recognize five eastern North American "rostrate" violets at the species level: *Viola adunca* Smith (sand violet), *V. conspersa* Reichb. (dog violet), *V. rostrata* Pursh (long-spurred violet), *V. striata* Aiton (cream violet), and *V. walteri* House (Walter's violet). The species differ in floral and vegetative morphology, ecological preference, range, and phenology.

The few mentions in the scientific literature of hybrids in the group have dealt mostly with crosses between *V. conspersa*, *V. rostrata*, and *V. striata*, three species which share a broad common range across the eastern United States and southern Ontario. The first indication that hybridization occurred in North American "rostrate" violets was published by Malte and Macoun (1915) who made morphological observations on *V. conspersa* × *rostrata*. House (1924) later honored the primary discoverer by naming the hybrid *V.* ×*malteana* House.

In the same year, Brainerd (1924) described the morphology of *V. rostrata* × *striata* from specimens collected by E. Lucy Braun in Hamilton County, Ohio. Grover (1939) offered the name "×*Viola braunii*" for the hybrid to honor Dr. Braun; however, he referred only to Brainerd's English description and did not validly publish the name under the prevailing Botanical Code (Cooperrider 1986; Voss 1985). Cooperrider (1986) added to the known morphology of *V. rostrata* × *striata* and provided the Latin diagnosis necessary to publish the name *V.* ×*brauniae* Grover ex Cooperr. Henry (1953), Miller (1976), and Russell (1965) simply noted the existence of the two hybrids and presented localities for them without further comment.

Scoggan (1978) based his report of a third hybrid, *V. conspersa* × *striata*, on a specimen from Ontario cited by Gaiser and Moore (1966) in their Lambton County flora. Ballard (1990) found that the specimen was in fact *V. striata*. Nevertheless, he verified the existence of this hybrid for the first time on the basis of other specimens from several northeastern states, and named the hybrid *V.* ×*eclipes* H. Ballard.

Localities reported for hybrids have, in all but one case (Miller 1976), been few and widely scattered. Perusal of the taxonomic literature on eastern North American taxa of *Viola* would lead one to conclude that hybridization among the three species occurs sporadically and very rarely. Perhaps partly responsible for this paucity of records for hybrids is lack of sufficient detail in published taxonomic literature (including treatments of *Viola*) on the comparative morphology and ecology of species and hybrids. Consequently, in the research reported here, field and herbarium studies were conducted first to assess the true extent of hybridization among *Viola conspersa*, *V. rostrata*, and *V. striata*; and second, to clarify morphological and ecological patterns in, and determine diagnostic characters for identification of, these species and their hybrids.

METHODS

Preliminary studies using traditional herbarium methods determined which morphological features successfully separated the three species and their hybrids. Following this, intensive searches were made for hybrids during the period from 1982 to 1988 in approximately 3 dozen mixed-species populations of *V. conspersa*, *V. rostrata*, and *V. striata* encountered in southern Michigan. Where hybrids were found, specimens of the hybrids and the species were collected and pressed according to standard field techniques. The specimens are deposited at the herbarium of Michigan State University (MSC), excepting the holotype of *V.* ×*eclipes* which is deposited at the University of Michigan (MICH). Field observations included microhabitat conditions and distribution of the species and hybrids within each site.

During the same time period, herbarium specimens were examined from eighteen herbaria in the northeastern United States and Ontario. Floral and vegetative measurements were taken later on pressed specimens using a model 505-633 D15 Mitutoyo Dial Caliper and a standard metric ruler. During a visit to MICH, the collection dates were noted for fully developed flowering specimens of the three species from all counties in the three lowest tiers of non-coastal counties in southern Michigan; these data were used to construct a crude estimate of phenology for the species.

RESULTS

Morphological studies of specimens in the field and herbarium clarified species limits, variation patterns, and ecological features in the several taxa. Table 1 summarizes morphological and ecological characteristics found to be effective in distinguishing the taxa. Specific morphological and ecological features are detailed and illustrated in the Discussion.

Searches of many mixed-species populations in southern Michigan yielded hybrid specimens at nearly all sites. In some localities—specifically where two or more species intermingled over a broad area—hybrid individuals numbered in the hundreds. Field searches demonstrated that hybridization is extremely common at the population level.

Examinations were made of all herbarium specimens identified as *V. conspersa*, *V. rostrata*, and *V. striata* in collections at ALMA, AUB, CM, CMC, DAO, MICH, MO, MSC, NDG, OAC, OS, PAC, PENN, PH, TENN, WIS, WMU, and WUD (herbarium abbreviations from Holmgren et al. 1981). Of the 55 hybrid specimens that were located, only three were originally identi-

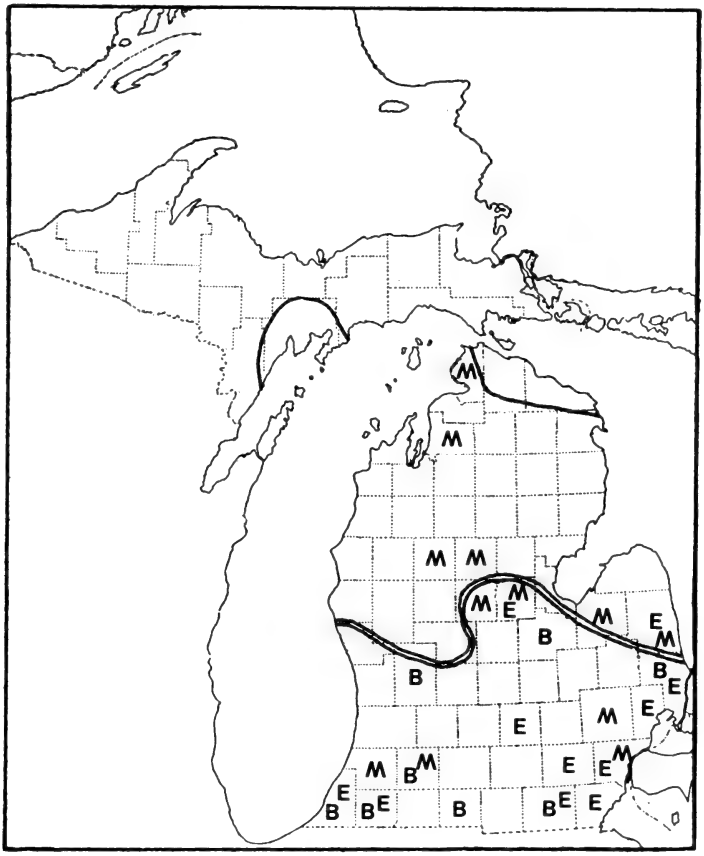


FIGURE 1. County distributions of *V.* ×*brauniae* (B), *V.* ×*eclipes* (E), and *V.* ×*malteana* (M) in Michigan; single line represents northern limit of *V. rostrata*, double line represents northern limit for *V. striata*. A list of specimens documenting these occurrences is available from the author.

fied correctly. Figure 1, based on thorough examinations of all major and most minor herbaria in Michigan, depicts relatively complete county distributions for all three hybrids in Michigan and gives an impression of the ranges of the parent species. The following representative specimens of the hybrids from elsewhere in eastern North America have been seen:

Viola ×*brauniae* Grover ex Cooperr. USA. OHIO. Hamilton Co.: near Terrace Park, 27 May 1971, *E. L. Braun s.n.* (VT). Medina Co.: SE of Valley City, Liverpool Twp., 22 May 1973, *Jones 73-5-22-518* (TENN). Richland Co.: 1 mi S of Rome, Blooming Grove Twp., 5 May 1976, *Jones 76-5-5-297* (TENN). Wayne Co.: Wooster Memorial Park, Plain Twp., 11 May 1976, *Jones 76-5-11-43* (TENN). PENNSYLVANIA. Bedford Co.: 5 mi SSW of Chaneysville, 31 May 1952, *Berkheimer 12747* (PH). Lawrence Co.: no locality, 31 May 1961, *L. K. Henry s.n.* (CM). Somerset Co.: no locality, 27 May 1950, *Buker s.n.* (CM). TENNESSEE. Blount Co.: Edge of Walland, 22 Apr 1934, *J.K.U. 585* (TENN). Franklin Co.: Floor of Cave Cove, 17 Apr 1986, *Clements 673* (TENN). VIRGINIA. Smyth Co.: Stoley's Creek

TABLE 1. Diagnostic and useful characters for *V. conspersa*, *V. rostrata*, *V. striata* and their hybrids

Character	*V. conspersa*	*V. × malteana*	*V. rostrata*	*V. × brauniae*	*V. striata*	*V. × eclipes*
FLOWERS						
Color pattern	solid, pale blue	weakly ocellate, light blue	strongly ocellate, lavender	weakly ocellate, pale lavender	solid ivory	pale blue with white eyespot
Lateral petal beards	present	present	absent	present	present	present
Spur length (mm)	ave. 4.6(4.0–5.0)	ave. 7.8 (6.5–9.5)	ave. 11.5 (8.4–15.5)	ave. 6.7 (4.5–8.3)	ave. 3.9 (3.0–4.8)	ave. 4.2 (4.0–5.0)
Spur: total spurred petal ratio	ave. 0.33 (0.30–0.39)	ave. 0.40 (0.34–0.44)	ave. 0.47 (0.42–0.53)	ave. 0.33 (0.28–0.39)	ave. 0.23 (0.19–0.27)	ave. 0.31 (0.26–0.33)
Sepal shape	lanceolate	lanceolate	lanceolate	linear-lanceolate	attenuate	linear-lanceolate
Sepal margin	eciliate	eciliate	eciliate	weakly ciliolate	ciliolate	weakly ciliolate
Auricles (mm)	ave. 1.24 (1.15–1.32)	ave. 1.07 (0.95–1.19)	ave. 0.81 (0.56–1.19)	ave. 1.86 (1.58–2.14)	ave. 2.03 (1.65–2.41)	ave. 1.84 (1.48–2.21)
FOLIAGE						
Median cauline leaf shape	reniform to broadly ovate, blunt	broadly ovate to ovate, acutish	ovate, acute	ovate, sharply acute	ovate, acuminate	ovate, acute
Leaf margin	shallowly crenate	crenate-dentate	regularly dentate	irregularly crenulate	irregularly crenulate	irregularly crenulate
Leaf vestiture	glabrous or isolated patches of clavate hairs	glabrous or rare patches of clavate hairs	glabrous or scattered minute spicules above	sparse spicules above near margin	spicules well scattered above near margin	sparse spicules above or patches of clavate hairs
Stipule shape	lanceolate	lanceolate or oblong	long-oblong	lanceolate	lance-ovate	broadly lanceolate
Stipule dissection	nearly entire or remotely lacerate	sparingly lacerate	moderately lacerate	moderately to strongly lacerate	strongly fimbriate	moderately lacerate
SPRING HABIT	short, ascending stems	short to moderately long, ascending stems	short, reclining to ascending	short, reclining stems	moderately long, ascending stems	moderately long, ascending stems
HABITAT						
Major communities	low mesic forests, hardwood and conifer swamps, aspen thickets	low mesic forests, hummocks in hardwood swamp forests	dry forests, slopes and hummocks in mesic and swamp forests	floodplains, base of dry slopes in low woods	floodplains, low wet woods	floodplains, low wet woods
Soil type and pH	loam, muck or peat; circumneutral to alkaline	sandy muck, slightly to moderately acid	sand or sandy loam, moderately acid	sandy or loamy silt, slightly acid to slightly alkaline	silt, moderately to strongly alkaline	sandy silt or muck, circumneutral to slightly alkaline
Soil moisture	moist to saturated	moist to slightly moist	dry to slight moist	slightly to moderately moist	moist to saturated	very moist

vicinity of Marion, 18 May 1892, *N. L. & E. G. Britton & A. M. Vail s.n.* (PH). CANADA. ONTARIO. Middlesex Co.: Lobo Twp., 1 mi NW of Coldstream, 14 May 1959, *H. Zavitz s.n.* (DAO).

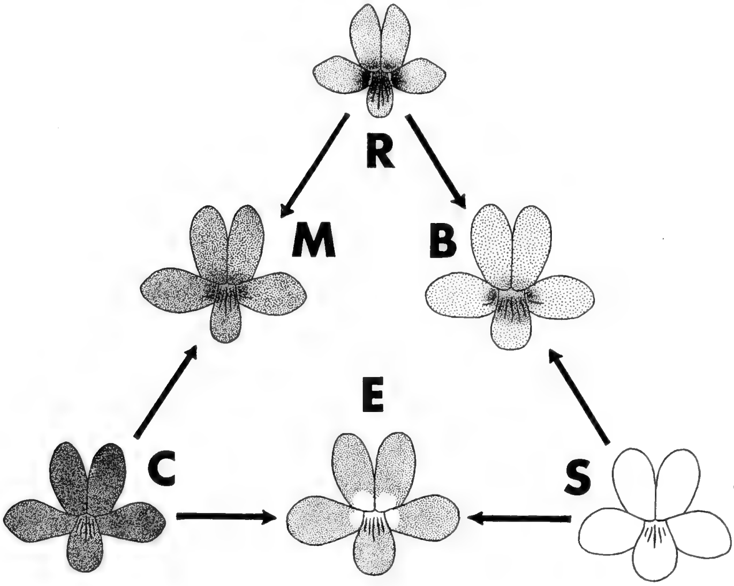
V. × *eclipes H. Ballard.* USA. ILLINOIS. Richland Co.: Gentry Creek, near Parkersburg, 26 Jun 1919, *Palmer 15605* (PH). INDIANA. St. Joseph Co.: Studebaker Woods, 26 May 1915, *J. A. Nieuwland s.n.* (NDG). KENTUCKY. Bell Co.: Cumberland Gap, National Historical Park, 4 May 1974, *Hinkle 47791* (TENN). MARYLAND. Allegheny Co.: Flintstone, 15 Jun 1967, *J. A. Churchill w/C. Henry s.n.* (MSC). MASSACHUSETTS, Essex Co.: Boxford, 30 May 1909, *F. F. Forbes s.n.* (KE). NEW YORK. Cortland Co.: Cortland, 16 Jun 1927, *C. Atwood s.n.* (WIS). PENNSYLVANIA. Bedford Co.: 1¾ mi SW of Mannschoice, 30 May 1945, *Berkheimer 5992* (PH). Fulton Co.: 1 mi S of Webster Mills, 8 Sep 1940, *Fogg 18586* (PH); Hellertown, *D. H. Detwiller s.n.*, 1829, (PH). TENNESSEE. Claiborne Co.: near Haro gate, 3 May 1960, *A. J. Sharp & J. W. Grear s.n.* (TENN). Bledsoe Co.: at Mt. Crest, 22 May 1987, *Jones 4772* (TENN). CANADA. ONTARIO. Middlesex Co.: 3 mi W of Strathroy at Metcalf, 14 May 1959, *H. Zavitz s.n.* (DAO).

V. × *malteana* House. USA. OHIO. Sciota Co.: Shawnee State Forest, 2 May 1935, *Demaree 11288* (PH). PENNSYLVANIA. Montgomery Co.: Perkiomen Creek above Schwenkville, 25 May 1924, *Dreisbach 2057* (PENN). TENNESSEE. Hawkins Co.: Laurel Branch, 16 Apr 1955, *Wolfe 19167* (TENN). VERMONT. Addison Co.: North Ferrisburg, Long Point, 24 May 1920, *E. M. Kittredge s.n.* (MO).

DISCUSSION

As representatives of subsection *Rostellatae*, *V. conspersa*, *V. rostrata*, *V. striata*, and their hybrids possess aerial stems; unlobed ovate leaves; lacerate stipules; cream, blue, or violet corollas; elongate floral spurs; green capsules; light to medium brown seeds; and a common chromosome number of $2n = 20$ (Clausen 1929, Canne 1987). All produce cleistogamous capsules in summer and characteristically retain the previous years' disintegrating stems.

Flower morphology. Flower morphology differs dramatically among the species. The most obvious differences include corolla color pattern (Fig. 2a), presence/absence of lateral petal beards, and relative spur length (Fig. 3a). Subtler, but nonetheless consistent, distinctions involve sepal shape (Fig. 3b) and ciliation, petal shape and orientation (expressed together in overall flower structure), and auricle length (Fig. 3c). Style features have been touted by specialists as reliable characters for identification; in fact, they have been used with chromosome numbers to form supraspecific phylogenetic groups and develop classifications for *Viola* worldwide. In the "rostrate" violets, certain differences are detectable and constant; for instance, the glabrous, slender, slightly hooked stigma of *V. rostrata* separates it readily from the bearded, stout, right-angled stigmas of its congeners. In studying style morphology throughout the genus in North America, however, I have found that style features show much more variability than specialists have previously been willing to admit. Given so many other easily discernable characters in all groups of eastern North American *Viola*, style morphology is highly impractical both for identification and for serious taxonomic use.



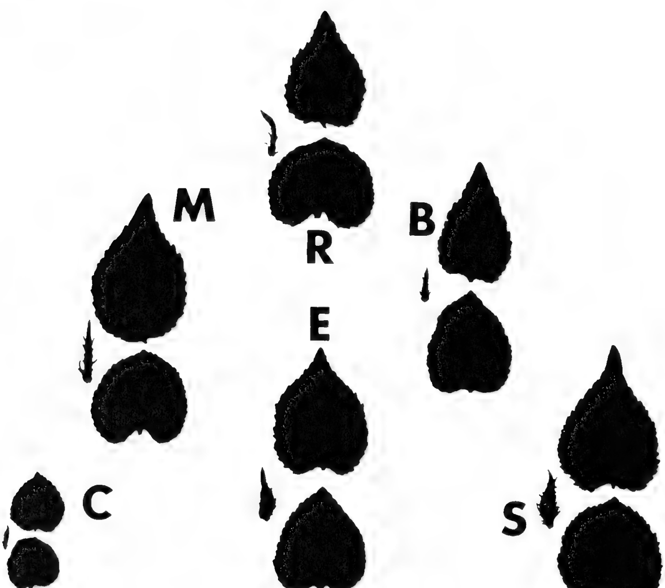


FIGURE 2. (a) Stylized corolla color patterns, (b) silhouettes of upper and median cauline leaves; C = *V. conspersa*, R = *V. rostrata*, S = *V. striata*, B = *V.* × *brauniae*, E = *V.* × *eclipes*, M = *V.* × *malteana*.

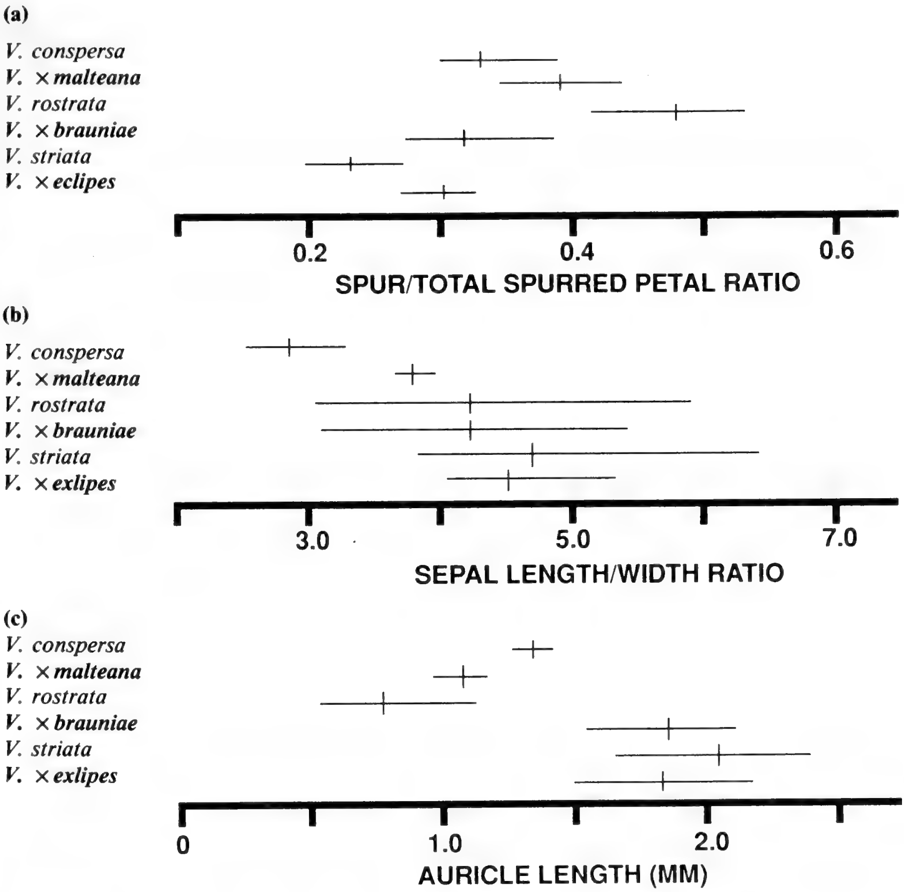


FIGURE 3. Bar graphs of (a) spur/total spurred petal ratio, (b) sepal length/width ratio, and (c) auricle length for all six taxa.

As noted in Table 1, the flower of *V. conspersa* is concolorous pale blue with heavy lateral petal beards, an elongate spur 4–5 mm long (about 35% of the total spurred petal length), and lance-ovate eciliate sepals with short auricles. The flower of *V. striata* is concolorous creamy white with heavy lateral petal beards, a comparatively short spur 3–5 mm long (about 23% of the total spurred petal length), and lance-linear ciliolate sepals with noticeably long auricles. The flower of *V. rostrata* is lavender and ocellate—bearing a heavy purple-black ring around its throat—without lateral petal beards, a very long spur 8–15 mm long (about 48% of total spurred petal length), and sepals like those of *V. conspersa*.

Hybrid combinations inherit similarly unique ensembles of morphological characters. As hybrids involving *V. rostrata*, *V.* ×*malteana* and *V.* ×*brauniae* always possess a noticeably darker ring around the throat and a

longer spur, both inherited from *V. rostrata*. For the same reason, *V. ×brauniae* and *V. ×eclipes* bear more attenuate, sparsely ciliolate sepals and longer auricles derived from their *V. striata* parentage. Knowing typical character states of only two easily observed floral features in the species—in particular, corolla color pattern and sepal ciliation—will permit 100% accurate identification of all fresh flowering specimens encountered. In older herbarium specimens color pattern is commonly lost or obscured; in such circumstances, features of sepals and spur may be relied upon for a comparably high level of accuracy in identification.

All morphological characters are intermediately expressed in the three hybrids, with one notable exception. While petal structure and pigmentation in *V. ×brauniae* and *V. ×malteana* are expressed in clearly intermediate fashion as one would expect (Fig. 2a), *Viola ×eclipes* bears a watery blue flower with a striking, large cream-white center. Far from being the concolorous flower of a hybrid between a cream-flowered and a blue-flowered species, this deviation appears to represent a synergistic expression of intermediate petal structure and differential petal pigmentation (Ballard 1990).

Vegetative morphology. Like floral morphology, foliage and habit are distinctive in the species and their interspecific crosses. In fact, intermediate stipule shape and dissection, and cauline leaf shape and pubescence originally inspired the conjecture that *V. conspersa × striata* existed and might be overlooked among specimens thought to be *V. conspersa*. The unique color pattern of *V. ×eclipes'* flower was noted only afterwards, in living specimens.

Major vegetative differences include shape and marginal dentation of leaves, and shape and dissection of stipules (Fig. 2b). Subtler but consistent features of habit, foliage color, and pubescence type and distribution are also useful—particularly on specimens lacking flowers. At flowering time *V. rostrata* has stems that strongly recline near the base and gradually ascend near the tips; stipules that are lance-oblong 10–20 mm, and bear a few large marginal processes; and ovate, acute, median cauline leaves with widely spaced crenations. Stems of *V. conspersa* recline near the base but are more erect near the tips; stipules are narrower than those of *V. rostrata* and shorter (up to 10 mm), and have fewer marginal processes; median cauline leaves are orbicular to reniform in outline and rounded to apiculate at the apex, with regular, shallowly crenate margins. *Viola striata* has even more erect stems than the other two species; lance-ovate, heavily fimbriate stipules up to 15 mm long; and median cauline leaves that are similar to the ovate outline of *V. rostrata*'s but more acuminate, and with crenulate margins.

Stem height and overall size of vegetative parts in the hybrids is exaggerated by heterosis; hybrids have taller, more numerous stems and more flowers and leaves than the species. This robust nature often distinguishes hybrid individuals from the species at a distance of several yards.

The six taxa are easily differentiated at flowering time. After anthesis, distinctive vegetative features gradually converge: stems elongate and become erect, stipules and leaf apices elongate, and leaf dentation becomes irregularly crenate-serrate. Using fruiting specimens for identification in these taxa is possible once one becomes familiar with seasonal variation

patterns and subtler vegetative features, but it is a poor alternative to using flowering specimens.

The following key distinguishes flowering specimens (accounting for but not distinguishing albinos) of all native taxa of subsection *Rostellatae* represented in eastern North America, as recognized by the author. The hybrid of *V. adunca* and *V. conspersa* is presently poorly delimited and difficult to identify without intimate familiarity with variation patterns in the parent species; consequently, it is not specifically keyed out below but would fall out under *V. adunca*.

KEY TO NATIVE VIOLET (*VIOLA*) SPECIES OF SUBSECTION ROSTELLATAE, SECTION NOMIMIUM IN THE NORTHEASTERN UNITED STATES AND CANADA

1. Lateral petals unbearded; corolla lavender with heavy purple-black ring around throat.............................. *V. rostrata* Pursh
1. Lateral petals bearded; corolla various
    2. Corolla with weak purple-black ring around throat or conspicuous cream-white center
        3. Corolla watery light blue with large cream-white center; sepals sparsely ciliolate (use strong hand-lens); stipules moderately to strongly lacerate along margins ... *V.* ×*eclipes* Ballard
        3. Corolla pale blue-violet with weak purple-black ring around throat; sepals and stipules various
            4. Sepals sparsely ciliolate; stipules moderately lacerate; median cauline leaves ovate and noticeably acuminate at apex, their margins irregularly crenulate.... *V.* ×*brauniae* Grover ex Cooperr.
            4. Sepals eciliate; stipules weakly lacerate; median cauline leaves broadly ovate to reniform and obtuse or rounded at apex, their margins low-crenate...... *V.* ×*malteana* House
    2. Corolla concolorous (either solid cream-white or various shades of blue)
        5. Corolla cream-white; spur <5 mm (totaling under 30% of total spurred petal length); sepals sparingly to strongly ciliolate; median cauline leaves ovate and acute to acuminate at apex, their margins closely crenulate....... *V. striata* Aiton
        5. Corolla pale or dark blue; spur >4 mm (30% or more of total spurred petal length); eciliate; median cauline leaves not as above
            6. Stems prostrate, node-rooting, and forming mats of interconnected plants; primarily Appalachian and southeastern (disjunct in south-central Ohio) ... *V. walteri* House

6. Stems aerial, at most ascending and never node-rooting; widespread across northeastern North America
   7. Fresh foliage light green to yellow-green, glabrous (occasionally with scattered patches of clavate hairs); median cauline leaves broadly ovate to reniform, blunt or apiculate, deeply cordate; fresh corolla pale blue. . . . . *V. conspersa* Reichb.
   7. Fresh foliage blue-green, densely puberulent with tiny subulate hairs (occasionally glabrous, as f. *glabra* (Brainerd) G. N. Jones); median cauline leaves narrowly ovate to triangular, rounded at the very tip, shallowly cordate to truncate at base; fresh corolla dark blue [hybrids w/*V. conspersa* would key out here]. . . . . *V. adunca*

ECOLOGICAL OBSERVATIONS

Habitat. Each species occupies characteristic forest communities with particular conditions of soil moisture, texture, and pH. While species often occur in proximity in certain natural community types, their relative abundances within those communities differ according to the different microhabitats represented. For instance, *V. conspersa* thrives in mesic to wet-mesic, acidic to alkaline loam, peat, or sand; it is found most often in mesic (sugar maple) forests, white cedar and bog forests, and swamps. *Viola rostrata* grows on droughty, weakly to strongly acidic sandy soils. Among the three species, it occurs in the most acidic soils perhaps rivaled only by *V. conspersa* under suitable circumstances. Whereas *V. conspersa* occupies moist or saturated soils, *V. rostrata* occupies dry types; it is especially common in xeric oak forests, but is frequent on dry microsites such as steep banks and hummocks in mesic and swamp forests. *Viola striata* is characteristic of saturated, alkaline silts, reaching its peak abundance in floodplains. It occurs in the least acidic soils.

Wherever disturbance, topographic discontinuities, or habitat intergradation bring different soils together, individuals of two or more species are commonly found in close proximity. Such "intermediate" situations as described by Anderson (1948) are prime localities for hybrids. Hybrid plants are always near one of the parent species; their relative abundance appears to be directly proportional to the amount of "intermediate" microhabitat that is available.

Phenology. Each species reaches peak bloom at a somewhat different time (Fig. 4). While phenology overlaps significantly, timing appears sufficiently skewed to limit gene flow between species. Co-occurring species at a given site are generally at different phenological stages, the earlier species often losing corollas and developing capsules as the later species are just coming into full bloom. Hybrid phenology appears to have a broader time distribution, often beginning after the earlier parent species has peaked and surpassing the last blooming individuals of the later parent species.

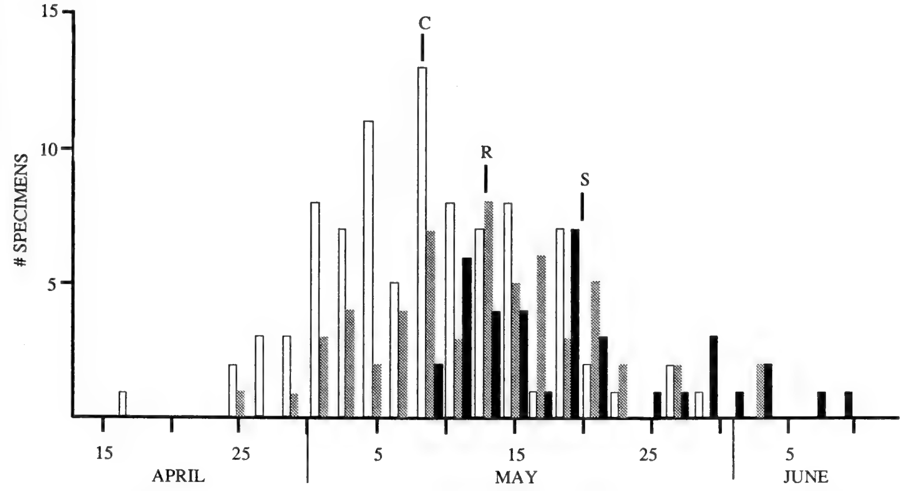


FIGURE 4. Phenology of *V. conspersa* (white), *V. rostrata* (gray), and *V. striata* (black) based on specimens at MICH from south-central Michigan; initials of specific epithets indicate means of collection dates for each species.

It is interesting to note that *V. conspersa*, which is partial to saturated peat and muck soils, typically reaches peak bloom weeks earlier than *V. striata*, a species also characteristic of moist, heavy silts. However, *V. rostrata* peaks between the other two species in its well-drained, sandy soils. Allopatric populations of these species show the same general phenology as co-occurring species. These observations suggest that phenology is genetically based in the trio, and is not the direct result of local environmental factors.

Reproductive isolation. Given the high frequency of hybridization at the local level, one would expect to find hybrid swarms—populations of F_2 and later-generation segregates and backcrosses showing a wide range of phenotypes. I have made exhaustive searches of many hybridizing populations for evidence of introgression but have found only one putative backcross specimen. This peculiar plant grew next to *V. striata* and within a few centimeters of *V. rostrata* and *V.* × *brauniae* along a woodland path. Its floral and vegetative morphology and habit were like *V. striata*, except for two features: the spurs were slightly longer, gently upturned, truncate and purplish-tinged; and the lateral petals had a faint purplish blush just above the throat, in the position one finds heavy purple blotches on the ocellate corolla of *V. rostrata* (and the weakly ocellate corolla of *V.* × *brauniae*).

The rarity of apparent backcrosses or later-generation segregates despite continued searches over several successive years, and the common and widespread occurrence of F_1 hybrids in natural populations, reflect strong internal isolating mechanisms (in the sense of Grant 1971) that do not prevent initial interspecific hybridization but do severely limit further gene flow between species and hybrids beyond the first generation. Phenological isolation probably reduces gene flow among the species, and ecological isolation appears to restrict the seedling establishment of F_1 hybrids through pre-

adaptation to certain microhabitat conditions and through competition between seedlings of hybrids and species in "intermediate" microsites. Beattie (1974) found that a third isolating mechanism, mechanical isolation (acting synergistically with phenological isolation), served to restrict gene flow between *V. rostrata* and *V. striata* due to strongly differing floral structure that led to substantially different classes of insect pollinators. It is likely that future studies of ultraviolet corolla color patterns, meiosis, pollen fertility, seed set, and seedling establishment and success under differing microhabitat conditions in the species and their hybrids would shed more light on the nature of hybridization, reproductive isolation, and perhaps evolution, in this interesting group of violets.

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THE HAMPTON CREEK WETLAND COMPLEX IN SOUTHWESTERN MICHIGAN. VI. TRANSECT SURVEY OF BRYOPHYTE POPULATIONS

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INTRODUCTION

The Hampton Creek wetland complex in southwestern Michigan is the subject of a series of studies conducted in the Department of Biological Sciences at Western Michigan University. Earlier papers by Sytsma and Pippen dealt with the history and physical features (1981a), the classification of plant communities (1981b), structure and succession of tamarack forests (1982a), fen succession (1982b), and the species of vascular plants present in the area (1982c).

This paper presents the first study of the bryophytes of the area. The earlier studies concentrated on the vascular plant flora and mentioned a few bryophytes only incidentally. Additional studies are being planned to more completely examine the bryoflora, its species composition, community structure, and its relationships to the vascular plants and ecology of the area.

The majority of wetland studies in Michigan have been undertaken in the northern Lower Peninsula and the eastern Upper Peninsula (Sytsma & Pippen 1981b). There is also a long and distinguished history of bryological studies in Michigan. Nonetheless, the southwestern portion of the state is under-represented in these studies and in herbarium collections of bryophytes (H. Crum, pers. comm.). This paper is a first step in remedying that situation.

THE STUDY SITE

The Hampton Creek wetland complex is an ecologically rich area in Portage Township of Kalamazoo County (NW 1/4 of Sect. 19,T3S,R11W). The 60 acre (24 ha) site lies 150 m SE of the intersection of US 131 and Center Street. Its physical features, history, climate, and soils have been described elsewhere (Sytsma & Pippen 1981a). The site is owned and managed by the Michigan Department of Natural Resources as part of the Gourdneck Game Preserve. Given the rapid growth of the City of Portage, it is likely that hunting and the discharge of firearms will be prohibited at some point in the future. When that occurs and the original reason for the

preserve changes, monitoring of real estate development activities in the area will be essential to insure that the site is preserved indefinitely.

The first paper in this series (Sytsma & Pippen 1981a) listed fourteen species of vascular plants in the Hampton Creek wetland complex as rare and threatened. Of these, nine were included (Sytsma & Pippen 1982c) in the tentative list of endangered, threatened, and rare vascular plants in Michigan (Wagner, et al. 1977). The complex may also provide environments for infrequently seen mosses and liverworts.

The nature and location of seven major plant communities have been described in the Hampton Creek wetland complex (Sytsma & Pippen 1981b). These are identified as emergent aquatic, southern sedge meadow, fen, wet mesic prairie, shrub-carr, wet northern forest, and wet-mesic southern hardwoods. While most of the area is low-lying and wet, it is bordered on the north by a ridge running as much as 6 m above the rest of the area. This oak-forested ridge is topped by a reforestation planting of red pine.

METHODS

After examining aerial photos and maps and considering alternatives based on several field visits, a 600 m transect line was laid to conduct the preliminary survey of bryophytes reported here. The location of this transect is shown in Fig. 1. While several such transects would have been desirable and may yet be completed as components of future studies, it was determined that the transect selected would pass through several major habitat types and thus yield an initial view of the nature of the bryophyte populations.

The transect line begins in the reforestation planting of red pine and extends through mesic dry prairie, oak forest, shrub-carr, southern sedge meadow, wet northern forest, and wet mesic southern hardwoods before terminating in oak forest. Each of these can be characterized by a few dominant species as indicated in Table 1. The number of quadrats sampled and the relationship between the habitat types and Sytsma and Pippen's (1981b) community types are presented in Table 2. The fen, emergent aquatic, and wet mesic prairie communities did not occur along the transect line. The bryophytes of these communities will be the subject of subsequent studies.

The study design required the sampling of the transect at approximately 10 m intervals. A random number generator was used to determine the location along the transect of not fewer than 60 m^2 quadrats for detailed analysis with the additional provision that no habitat type be sampled fewer than four or more than ten times. Table 2 indicates that these conditions have been met. The average distance between the 63 sampling sites for the transect as a whole was 96.7 m. The average distance between quadrats for each habitat type is given in Table 2.

Each quadrat was divided into one hundred 0.1 m^2 sections by overlaying it with a flexible string net (Fig. 2), allowing easy placement on irregular surfaces. The presence or absence of bryophytes in each 0.1 m^2 section of the grid was recorded for the calculation of frequencies.

Voucher specimens were collected from each quadrat containing bryophytes and photographs were taken to record microhabitat details. Identifications and analyses were made in the laboratory using the keys and descriptions of Crum (1985), Darlington (1964), Schuster (1953), and Steere (1940) along with the bryophyte collection of the Hanes Herbarium (WMU) of Western Michigan University. A set of voucher specimens has been deposited at WMU. Field work, transect development, and collecting were done in the fall of 1987. Nomenclature was standardized to that of Crum (1985) for the mosses and Crum (1990) for the liverworts.

The degree of similarity of the species present in each habitat type was calculated using Grieg-Smith's (1964) index of similarity. In this calculation, the index equals $\mathbf{2c/a+b}$, where **a** represents the species present in one habitat type, **b** the species in another, and **c** the species found in both. In this index, values range from 0 (no similarity) to 1.0 (complete similarity).

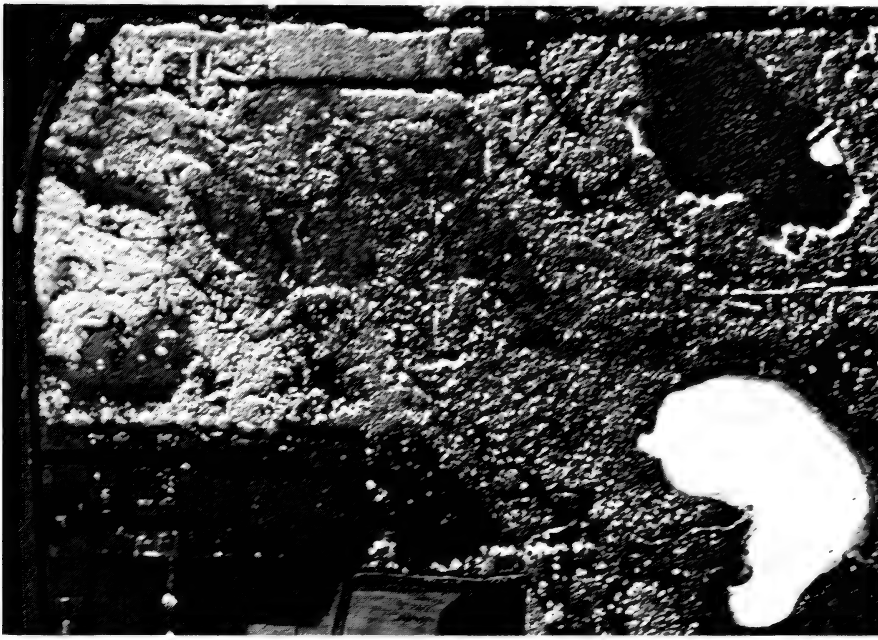

FIGURE 1. Aerial photo from color infrared transparency showing location of the transect line through Hampton Creek Wetland. Hampton Lake is shown in the lower right corner. The transect begins in the pine plantation at the upper right and traverses mesic dry prairie, oak forest, shrub-carr, southern sedge meadow, wet northern forest, wet mesic southern hardwoods, and ends in oak forest. See Table 2 for distances along the transect for these habitat types.

RESULTS AND DISCUSSION

Of the 63 quadrats sampled, 40 (63.5%) contained bryophytes. The distribution of bryophyte-containing quadrats among the seven habitat types is shown in Table 3. The difference in the presence of bryophytes between the higher, sandy, well-drained portions of the transect and the lower, organic soil, water-retaining portions is dramatic. In the pine plantation, mesic dry prairie, and oak forest sections, only 25, 60, and 31% respectively of the quadrats contained bryophytes, whereas in the shrub-carr, southern sedge meadow, wet northern forest, and wet mesic southern hardwood sections of the transect, they were present in 100% of the quadrats. This provides further confirmation of the moisture dependency of bryophytes discussed by Schofield (1985), Chopra & Kuma (1988), and others.

Bryophyte frequency along the entire transect, i.e. the percentage of the quadrat's grid sections that contained bryophytes, was 17.5%. Taking only those quadrats which contained bryophytes, frequency was 27.5%. Frequen-

TABLE 1. Dominant vascular plants by habitat types.

Habitat type	Dominant vascular plants
Pine Plantation	*Pinus resinosa* Aiton (Red Pine)
Mesic Dry Prairie	Poaceae (Grasses)
Oak Forest	*Quercus alba* L. (White Oak)
	Q. borealis Michaux f. (Red Oak)
	Q. velutina Lam. (Black Oak)
Shrub-Carr	*Cornus racemosa* Lam. (Gray Dogwood)
Southern Sedge Meadow	*Carex* spp. (Sedges)
Wet Northern Forest	*Larix larcina* (Duroi) K. Koch (Tamarack)
	Toxicodendron vernix (L.) Kuntze (Poison Sumac)
Wet Mesic Southern Hardwoods	*Quercus* spp. (Red Oak species complex)
	Q. palustris Muenchh. (Pin Oak)
	Betula alleghaniensis Britton (Yellow Birch)
	Populus tremuloides Michaux (Trembling Aspen)

TABLE 2. Distances and numbers of quadrats by habitat type along the transect line.

Transect section (m)	Length (m)	Quadrats (#)	Distance between quadrats (ave m)	Habitat type	Sytsma & Pippen (1981b) Community type
0– 76	76	8	9.5	Pine Plantation	– – –
76–120	44	5	8.8	Mesic Dry Prairie	– – –
120–200	80	8	10.0	Pine Plantation	– – –
200–254	54	7	7.7	Oak Forest	– – –
254–340	86	9	9.6	Shrub-Carr	Shrub-Carr
340–396	56	4	14.0	S. Sedge Meadow	S. Sedge Meadow
396–488	92	9	10.2	Wet Northern Forest	Wet Northern Forest
488–550	62	7	8.9	Wet Mesic Southern Hardwoods	Wet Mesic Southern Hardwoods
550–600	50	6	8.3	Oak Forest	– – –
– – –	–	–	– –	– – –	Emergent Aquatic
– – –	–	–	– –	– – –	Fen
– – –	–	–	– –	– – –	Wet Mesic Prairie

cies for the 26 species of bryophytes found in the 40 bryophyte-containing quadrats is given in Table 4.

When sorted by habitat types (Table 5), it can be seen that the greatest number of species were found in the shrub-carr and the southern hardwood forest; the least number occurred in the more environmentally uniform sedge meadow and dry prairie. Several species were present in several habitat types.

The most generally occurring bryophyte, *Rhynchostegium serrulatum*, was found in five of the seven habitat types. *Callicladium haldanianum* and *Leptodictyum riparium* occurred in four habitat types; *Eurhynchium pulchellum* and *Lophocolea heterophylla* in three; and *Ceratodon purpureus*,

FIGURE 2. Flexible quadrat sampling net in use.

TABLE 3. Distribution of bryophyte-containing quadrats among seven habitat types.

Habitat type	Bryophyte-containing quadrats (#)	Total quadrats sampled (#)	% of quadrats containing bryophytes
Pine Plantation	4	16	25
Mesic Dry Prairie	3	5	60
Oak Forest	4	13	31
Shrub-Carr	9	9	100
Southern Sedge Meadow	4	4	100
Wet Northern Forest	9	9	100
Wet Mesic Southern Hardwoods	7	7	100
Totals	40	63	

Pallavacinia lyellii, *Brachythecium rutabulum*, *Mnium cuspidatum*, and *Thuidium delicatulum* in two. The remaining species were found in only one habitat type.

The species encountered in the quadrats also sort themselves by microhabitats (Table 6). In sandy open places, *Ceratodon purpureus* and *Polytrichum piliferum* are most likely to occur. On sandy loam in woods, the most

TABLE 4. Percent frequency in bryophyte-containing quadrats.

Rank	% Frequency	Species
1	17.77	*Thuidium delicatulum* (Hedw.) BSG
2	13.06	*Leptodictyum riparium* (Hedw.) Warnst.
3	12.06	*Eurhynchium pulchellum* (Hedw.) Jenn
4	10.61	*Callicladium haldanianum* (Grev.) Crum
5	6.07	*Brachythecium curtum* (Lindb.) Limpr.
6	5.08	*Polytrichum piliferum* Hedw.
7	4.99	*Lophocolea heterophylla* (Schrad.) Dum.
8	4.80	*Pallavacinia lyellii* (Hook.) Carruth.
9	3.99	*Platygyrium repens* (Brid.) BSG
10	3.99	*Brachythecium rutabulum* (Hedw.) BSG
11	3.17	*Polytrichum commune* Hedw.
12	3.08	*Hypnum lindbergii* Mitt.
13	1.99	*Pohlia nutans* (Hedw.) Lindb.
14	1.63	*Rhynchostegium serrulatum* (Hedw.) Jaeg. & Sauerb.
15	1.63	*Plagiothecium laetum* BSG
16	1.54	*Mnium cuspidatum* Hedw.
17	0.99	*Calypogeia muelleriana* (Schiffn.) K. Müll.
18	0.91	*Fissidens osmundioides* Hedw.
19	0.45	*Hypnum pallescens* (Hedw.) P. Beauv.
20	0.45	*Ceratodon purpureus* (Hedw.) Brid.
21	0.36	*Bryohaplocladium microphyllum* (Hedw.) Wat. & Iwats.
22	0.36	*Atrichum angustatum* (Brid.) BSG
23	0.18	*Aulacomnium palustre* (Hedw.) Schwaegr.
24	0.09	*Pellia epiphylla* (L.) Corda
25	0.09	*Dicranum scoparium* Hedw.
26	0.09	*Climacium dendroides* (Hedw.) Web. & Mohr

commonly encountered species are *Atrichum angustatum*, *Dicranum scoparium*, *Mnium cuspidatum*, and *Rhynchostegium serrulatum*. On moist fallen logs, the most frequently found species are *Callicladium haldanianum*, *Lophocolea heterophylla*, *Rhynchostegium serrulatum*, and *Thuidium delicatulum*. On rich black soils, the most frequently seen bryophytes are *Aulacomnium palustre*, *Climacium dendroides*, and *Eurhynchium pulchellum*. On tree bases, the commonly found bryophytes are *Callicladium haldanianum*, *Lophocolea heterophylla*, and *Platygyrium repens*.

The indices of similarity between all possible pairs of bryophyte habitat types are given in Table 7. The greatest similarities in bryophyte species composition occurred in adjacent vascular plant communities where edaphic and hydrologic conditions were most likely to be similar. The least similarity occurred between the oak forest on the one hand and the pine plantation, sedge meadow, and mesic dry prairie on the other. Since the oak forest, pine plantation, and mesic dry prairie are adjacent and share similar edaphic and hydrologic circumstances, the most probable explanation for their lack of similarity in bryophyte species composition lies in the comparative density of the canopy layer and its relationship to the amount of light reaching the bryophytes. Van Der Linden and Farrar (1983) found a strong correlation between light intensity and bryophyte distribution with the light

TABLE 5. Species distribution by habitat types.

	Pine	Dry Prairie	Oak Forest	Shrub-Carr	Sedge Meadow	Northern Forest	Southern Hardwood
Atrichum angustatum				x			
Aulacomnium palustre						x	
Brachythecium curtum						x	
B. rutabulum				x			x
Bryohaplocladium microphyllum				x			
Callicladium haldanianum			x	x		x	x
Calypogeia muelleriana							x
Ceratodon purpureus	x						
Climacium dendroides				x			
Dicranum scoparium				x			
Eurhynchium pulchellum				x		x	x
Fissidens osmundioides				x			
Hypnum lindbergii						x	
H. pallescens				x			
Leptodictyum riparium				x	x	x	x
Lophocolea heterophylla	x			x			x
Mnium cuspidatum				x			x
Pallavacinia lyellii			x				x
Pellia epiphylla							x
Plagiothecium laetum							x
Platygyrium repens			x				
Pohlia nutans	x						
Polytrichum commune		x					
P. piliferum	x						
Rhynchostegium serrulatum	x	x		x	x	x	
Thuidium delicatulum				x			x

intensity largely determined by vascular plant density and height. In our study area, the oak forest provides a fairly continuous, but light, shade. The floor of the pine plantation is densely shaded with little ground cover. The dry prairie has no canopy layer but the ground cover is fairly continuous. These relationships require additional investigation before more definitive statements can be made about them.

Comparisons between the indices of similarity for the vascular plant communities calculated by Sytsma and Pippen (1981b) and those of the bryophyte habitat types (Table 7) are complicated by the fact that Sytsma and Pippen (1981b) did not include the pine plantation, dry mesic forest, and oak forest, and this study does not include the emergent aquatic, wet mesic prairie, and fen communities. Nonetheless, in examining the six cases in which direct comparisons can be made, it is interesting to note that the degree of similarity in the bryophyte species present is higher in every case than that for the vascular plants. It is also noteworthy that the pairs fall in a very similar descending order. Until more data are acquired, we can only speculate that the bryophytes show greater ability to survive in a broader range of habitats than the vascular plants, but that similar factors are influencing the distribution of both. The subject of the relationship between vascular plant and

TABLE 6. Bryophyte species distribution by substrate microhabitats.

	Sandy Open	Sandy Wooded	Fallen Logs	Black Soil	Tree Bases
Atrichum angustatum		x		x	
Aulacomnium palustre				x	
Brachythecium curtum		x			
B. rutabulum			x	x	
Bryohaplocladium microphyllum		x			
Callicladium haldanianum		x	x	x	x
Calypogeia muelleriana				x	
Ceratodon purpureus	x				
Climacium dendroides				x	
Dicranum scoparium		x			
Eurhynchium pulchellum		x		x	
Fissidens osmundioides			x		
Hypnum lindbergii				x	
H. pallescens			x		
Leptodictyum riparium		x	x	x	
Lophocolea heterophylla		x	x		x
Mnium cuspidatum		x			
Pallavacinia lyellii			x		
Pellia epiphylla			x		
Plagiothecium laetum		x			
Platygyrium repens		x			x
Pohlia nutans		x			
Polytrichum commune	x				
P. piliferum	x				
Rhynchostegium serrulatum		x	x	x	x
Thuidium delicatulum		x	x	x	

bryophyte communities merits further study, and the Hampton Creek Wetland Complex seems to be ideally suited for such studies.

In addition to the 26 species found along the transect, 17 other species of bryophytes have been collected from the Gourdneck Game Preserve and incorporated into the bryophyte collection of the Hanes Herbarium (WMU). This number is expected to increase substantially, particularly as the fen populations are studied.

SUMMARY

The bryophyte populations of the Hampton Creek wetland complex have been examined via a 63-quadrat transect study. Forty of the 63 quadrats contained bryophytes. Twenty-six species of mosses and liverworts are present in seven habitat types. The distribution of bryophytes has been measured as a percentage of the quadrat sections occupied by bryophytes in each habitat type. Frequency was found to be 17.5 for all quadrats and 27.5 for bryophyte-containing quadrats. Frequency was measured for each bryophyte species. *Thuidium delicatulum* was present in 17.77% of the bryophyte-containing quadrats. The greatest number of species (14) occurs in the shrub-carr habitat type. The substrate environments containing the greatest number of bryophyte species were sandy loam in woods (14 species) and rich black organic soil (11 species).

Indices of similarity calculated for all possible pairs of habitat types indicate that the bryophyte communities in these habitat types are most similar when the habitats are adjacent

TABLE 7. Descending order of similarity between pairs of bryophyte habitat types compared with similarities between pairs of vascular plant communities.

Bryo. Sim. Index	Habitat Types	Vasc. Plant Sim. Index
.66	Pine Plant.: Mesic Dry Prairie	– – –
.60	Sedge Meadow: Wet N. Forest	.30
.56	Shrub-Carr: Wet Mesic S. Hardwoods	.20 - 0-.17
.38	Shrub-Carr: Wet N. Forest	.19-.17-.09
.35	Shrub-Carr: Sedge Meadow	.13-.10-.11
.33	Wet N. Forest: Wet Mesic S. Hardwoods	.19
.28	Oak Forest: Wet Mesic S. Hardwoods	– – –
.28	Sedge Meadow: Mesic Dry Prairie	– – –
.28	Sedge Meadow: Wet Mesic S. Forest	.13
.25	Pine Plantation: Sedge Meadow	– – –
.21	Pine Plantation: Shrub-Carr	– – –
.20	Oak Forest: Wet N. Forest	– – –
.18	Mesic Dry Prairie: Wet N. Forest	– – –
.16	Pine Plantation: Wet N. Forest	– – –
.12	Pine Plantation: Wet Mesic S. Hardwoods	– – –
.11	Oak Forest: Shrub-Carr	– – –
.11	Mesic Dry Prairie: Shrub-Carr	– – –
.00	Oak Forest: Pine Plantation	– – –
.00	Oak Forest: Sedge Meadow	– – –
.00	Oak Forest: Mesic Dry Prairie	– – –
.00	Wet Mesic S. Hardwoods: Mesic Dry Prairie	– – –

and share similar edaphic and hydrologic circumstances. Comparison of the indices of similarity calculated for the bryophyte habitat types with those of the vascular plant communities suggests some interesting parallels meriting further study. The Hampton Creek wetland complex seems to be ideally suited for continuing study of the nature of bryophyte associations and their relationship to vascular plant communities. Additional work is being planned.

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REVIEW

MUSHROOMS. A Quick Reference Guide to Mushrooms of North America. By Alan Bessette and Walter J. Sundberg. Collier Books, Macmillan Publishing Co., New York, and Collier Macmillan Publishers, London. 1987. xvi + 173 pp. $12.95 softbound, $24.95 hardcover.

There is no shortage of recent mushroom guides, but this one has much to commend. There is a brief introduction, fairly conventional in scope, covering the places of fungi and mushrooms among living organisms, using the guide, making a spore print, suggestions for collecting and eating wild mushrooms; followed by a checklist of field characters. The main body consists of illustrations of over 200 species with descriptions on facing pages. The species were selected for all of North America with more than half found in Michigan and the Great Lakes region. The relatively small number of species is extended by mention of similar species in each description. The small size of the color plates (three or four per octavo-size page) is more than compensated for by good color and perspective emphasizing significant features. Purists may object to the absence of dichotomous keys and the extensive use of common names. Species are grouped by shape or form. This arrangement, not unique to this guide, allows one unaccustomed to, or intimidated by, dichotomous keys to move promptly to the proper group. While species of disparate classification may be grouped together, the description of each species also names the family. While a common name may be listed first, these authors have not succumbed to concocting a "common" name where none was evident. A Latin binomial is given for every species as well as an explicit statement of status concerning edibility or toxicity and succinct mention of appearance, spore color, fruiting and range, with brief comments. The section on microscopic spore characteristics, most of which is a table of spore data for over 500 species, is unusual in a guide of this type. That table, alone, could justify this book for even the very experienced mycologist. Veteran Michigan members might note that the authors are second-generation students of Alexander Smith; Bessette through Richard Homola, Sundberg through Harry Thiers; the Michigan tradition is carried on. Bessette and Sundberg are dedicated teachers and have produced an excellent, compact guide useful to both beginning and advanced mushroomers.

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LICHENS OF APOSTLE ISLANDS NATIONAL LAKESHORE, WISCONSIN

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Apostle Islands National Lakeshore is located in northern Wisconsin in the western end of Lake Superior. The park includes islands in Lake Superior and a narrow zone along the northern end of the Bayfield Peninsula, which extends out from the south shore of the lake. The park was established in 1970 with 42,000 acres and includes 21 of the 22 islands in the archipelago. The largest island, Madeline Island, is not included in the park. Most of the islands have been logged or burned and some have had land cleared for resorts, fishing camps, lighthouses, or other activities. Now most of the developments are gone and the forest is returning to its natural state.

The islands are at the border of the deciduous forest and the northern Great Lakes conifer forest. Most of the forest is maple (*Acer saccharum* Marshall and *A. rubrum* L.) with birch (*Betula papyrifera* Marshall and *B. alleghaniensis* Britton), and basswood (*Tilia americana* L.), and areas of hemlock (*Tsuga canadensis* (L.) Carrière). In wetter localities there are balsam fir (*Abies balsamea* (L.) Miller), eastern white cedar (*Thuja occidentalis* L.), white and black spruce (*Picea glauca* (Moench) Voss and *P. mariana* (Miller) BSP.). On rockier or drier sites some large white pine (*Pinus strobus* L.) or smaller red pines (*Pinus resinosa* Aiton) occur, but jack pines (*P. banksiana* Lambert) are quite rare. In areas of disturbance quaking aspens (*Populus tremuloides* Michaux) are abundant. There are few areas with rock outcrops except along the shores of some islands or around old quarries.

There is no published list of the lichens of the Apostle Islands but a few specimens have been cited in published revisions and monographs. In 1965, a field trip by the American Bryological and Lichenological Society collected lichens at three localities in Bayfield County between Bayfield and Cornucopia (Brodo 1967) but none of these localities is within the park. Botanists from Wisconsin have collected a few lichens in recent years and some specimens may be found in the herbaria of the state but were not available for this study.

Field work was done during August, 1987 when 1330 collections were made at 24 localities on 12 islands and on the mainland. A complete list of collection localities is given at the end of this paper and they are indicated on Fig. 1. Localities for collecting were selected first to give a general coverage of the park, second, to sample all vegetational and substrate types, and third, to be in localities that should be rich in lichens. Undisturbed as

well as disturbed habitats were studied. At each locality, voucher specimens of all species found were collected. The original packet of each collection has been deposited in the University of Minnesota Herbarium and a representative set of duplicates has been sent to the park and to the Smithsonian Institution. Label data for all specimens deposited at the University of Minnesota have been entered into the herbarium computerized data base.

LICHEN FLORA

The following list of lichens includes only the taxa collected for this study. There are also several unidentified species and some of these are probably undescribed taxa. References are given for those few specimens that have been cited in the literature from the park. In these cases, the names have been corrected to present nomenclature (Egan 1987) except that some of the segregate genera in that checklist are not recognized here. Species found only once are indicated by "Rare". Each species is followed by the locality number where it was found unless it was found at 6 or more localities, and then it is called "Common" followed by the number of different localities where it was collected. The locality numbers are included with the collection locality descriptions at the end of this paper.

Acarospora americana Magn. 1, 15
Acarospora fuscata (Nyl.) Arn. 2, 15
Anaptychia palmulata (Michaux) Vain. 5, 9
Anisomeridium biforme (Borr.) R. Harris Rare 7
Arthonia byssacea (Weigel) Almq. 13, 23 This species is rare in the Great Lakes Region. There are collections in MIN only from Isle Royale, Michigan.
Arthonia caesia (Flot.) Körb. 6, 16, 21
Arthonia patellulata Nyl. 2, 16, 21, 24
Arthonia punctiformis Ach. Rare 19
Arthonia radiata (Pers.) Ach. Rare 6
Arthonia spadicea Leight. Rare 16. There are collections in MIN also from northern Minnesota, northern Michigan, and the Slate Islands, Ontario.
Arthopyrenia punctiformis Mass. Rare 20
Aspicilia caesiocinerea (Nyl. ex Malbr.) Arn. 15, 20
Aspicilia cinerea (L.) Körb. Rare 6
Bacidia bagliettoana (Mass. & De Not.) Jatta Rare 15
Bacidia epixanthoides (Nyl.) Lett. 12, 13
Bacidia laurocerasi (Del. ex Duby) Ozenda & Clauz. Rare 19
Bacidia naegelii (Hepp) Zahlbr. 2, 21
Bacidia populorum (Mass.) Trev. Rare 3
Bacidia rubella (Hoffm.) Mass. Rare 12
Bacidia schweinitzii (Tuck.) Schneid. Common, 6 loc.
Bacidia suffusa (Fr.) Schneid. 6, 11, 17
Bryoria capillaris (Ach.) Brodo & Hawksw. 5, 13
Bryoria furcellata (Fr.) Brodo & Hawksw. (Brodo & Hawksworth 1977) Common, 10 loc.
Bryoria nadvornikiana (Gyeln.) Brodo & Hawksw. 19, 22
Bryoria trichodes (Michaux) Brodo & Hawksw. Common, 7 loc.
Buellia arnoldii Serv. 7, 8, 18, 21
Buellia disciformis (Fr.) Mudd Common, 14 loc.
Buellia punctata (Hoffm.) Mass. 14, 15, 18
Buellia schaereri De Not. 1, 4, 8, 18, 19
Buellia stillingiana Steiner Common, 7 loc.
Calicium abietinum Pers. Rare 4
Calicium salicinum Pers. 13, 24
Calicium trabinellum (Ach.) Ach. 4, 6, 10, 14
Caloplaca arenaria (Pers.) Müll. Arg. 15, 20
Caloplaca cerina (Ehrh. ex Hedw.) Th. Fr. Common, 6 loc.
Caloplaca flavovirescens (Wulf.) Dalla Torre & Sarnth. Rare 1
Caloplaca holocarpa (Hoffm.) Wade Common, 6 loc.

Candelaria concolor (Dicks.) B. Stein Common, 6 loc.
Candelaria fibrosa (Fr.) Müll. Arg. 3, 7, 16, 18
Candelariella efflorescens R. Harris & Buck 6, 9, 24
Candelariella vitellina (Hoffm.) Müll. Arg. 1, 15, 20
Cetraria halei W. Culb. & C. Culb. Common, 7 loc.
Cetraria orbata (Nyl.) Fink 4, 19
Cetraria pinastri (Scop.) Gray Common, 10 loc.
Cetraria sepincola (Ehrh.) Ach. 4, 8
Cetrelia chicitae (W. Culb.) W. Culb. & C. Culb. 1, 15, 16, 19, 22
Cetrelia olivetorum (Nyl.) W. Culb. & C. Culb. Common, 11 loc.
Chaenotheca brunneola (Ach.) Müll. Arg. 9, 10, 15
Chaenotheca chrysocephala (Turn. ex Ach.) Th. Fr. 16, 19, 22, 23
Chaenotheca ferruginea (Turn. ex Sm.) Mig. 13, 22
Chaenotheca furfuracea (L.) Tibell Rare 5
Chaenotheca laevigata Nadv. Rare 17
Chaenotheca stemonea (Ach.) Zw. Rare 19
Chaenotheca trichialis (Ach.) Th. Fr. 5, 10, 12, 19
Chaenotheca xyloxena Nadv. 17, 22
Chaenothecopsis debilis (Turn. & Borr. ex Sm.) Tibell Rare 23
Chaenothecopsis pusilla (Flörke) Schmidt Rare 5
Chaenothecopsis rubescens Vain. Rare 12
Chaenothecopsis savonica (Räs.) Tibell Rare 19. This species is also represented in MIN from northern Minnesota and northern Michigan.
Chrysothrix candelaris (L.) Laund. 5, 10, 13, 19
Cladina arbuscula (Wallr.) Hale & W. Culb. Rare 5
Cladina mitis (Sandst.) Hustich Common, 9 loc.
Cladina rangiferina (L.) Nyl. Common, 10 loc.
Cladina stellaris (Opiz) Brodo 4, 8, 18
Cladina stygia (Fr.) Ahti 4, 5. This recently recognized species is fairly common in the northern parts of the Great Lakes Region.
Cladonia amaurocraea (Flörke) Schaer. 5, 22
Cladonia bacillaris Nyl. Common, 6 loc.
Cladonia botrytes (Hagen) Willd. 10, 18
Cladonia caespiticia (Pers.) Flörke 3, 9, 13, 17, 19
Cladonia cenotea (Ach.) Schaer. Common, 7 loc.
Cladonia chlorophaea (Flörke ex Somm.) Spreng. Common, 13 loc.
Cladonia coniocraea (Flörke) Spreng. Common, 21 loc.
Cladonia cornuta (L.) Hoffm. Rare 8
Cladonia crispata (Ach.) Flot. 8, 10, 12, 15, 18
Cladonia cristatella Tuck. Common, 8 loc.
Cladonia cryptochlorophaea Asah. 5, 8, 20
Cladonia decorticata (Flörke) Spreng. 4, 18
Cladonia deformis (L.) Hoffm. 4, 8, 10, 15
Cladonia digitata (L.) Hoffm. Rare 14
Cladonia farinacea (Vain.) Evans Rare 9. In the Great Lakes Region there are specimens in MIN only from north central Minnesota.
Cladonia fimbriata (L.) Fr. Rare 1
Cladonia furcata (Huds.) Schrad. Rare 4
Cladonia gracilis (L.) Willd. Common, 7
Cladonia grayi G. K. Merr. ex Sandst. Rare 18
Cladonia humilis (With.) Laund. Rare 9
Cladonia incrassata Flörke Rare 14. Hale (1979) shows an eastern distribution for this species, not reaching Wisconsin.
Cladonia macilenta Hoffm. Rare 14
Cladonia merochlorophaea Asah. 2, 4, 10, 17
Cladonia multiformis G. K. Merr. Common, 6 loc.
Cladonia phyllophora Ehrh. ex Hoffm. 4, 8, 10, 18
Cladonia pleurota (Flörke) Schaer. 4, 8
Cladonia pyxidata (L.) Hoffm. Rare 8
Cladonia ramulosa (With.) Laund. 2, 4
Cladonia rei Schaer. 9, 10, 17, 20
Cladonia scabriuscula (Del.in Duby) Leight. Common, 13 loc.
Cladonia squamosa (Scop.) Hoffm. Common, 13 loc.
Cladonia subulata (L.) Web. ex Wigg. 9, 21
Cladonia sulphurina (Michaux) Fr. Rare 14
Cladonia turgida Ehrh. ex Hoffm. Rare 9
Cladonia uncialis (L.) Web. ex Wigg. Common, 6 loc.
Cladonia verticillata (Hoffm.) Schaer. 4, 9, 17, 18, 20
Collema subflaccidum Degel. 7, 9, 11, 12, 16
Conotrema urceolatum (Ach.) Tuck. Common, 12 loc. An eastern species extending to the south shore of Lake Superior, but not to Minnesota.
Cyphelium lucidum (Th. Fr.) Th. Fr. Rare 18
Cyphelium tigillare (Ach.) Ach. 4, 6, 8, 18
Dermatocarpon miniatum (L.) Mann Rare 1

Dimerella lutea (Dicks.) Trev. Common, 6 loc.
Dimerella pineti (Schrad. ex Ach.) Vezda Rare 5
Endocarpon pusillum Hedw. Rare 1
Evernia mesomorpha Nyl. Common, 20 loc.
Graphis scripta (L.) Ach. Common, 13 loc.
Haematomma pustulatum Brodo & W. Culb. Common, 10 loc.
Heterodermia hypoleuca (Muhl.) Trev. 3, 6
Heterodermia speciosa (Wulf.) Trev. Common, 13
Hypocenomyce anthracophila (Nyl.) James & G. Schneid. 1, 4
Hypocenomyce friesii (Ach. in Lilj.) James & G. Schneid. 4, 6, 8
Hypocenomyce scalaris (Ach. ex Lilj.) Choisy Common, 6 loc.
Hypogymnia physodes (L.) Nyl. Common, 23 loc.
Hypogymnia tubulosa (Schaer.) Hav. 4, 14, 15, 23
Icmadophila ericetorum (L.) Zahlbr. 5, 15, 22
Imshaugia aleurites (Ach.) S. F. Meyer 4, 8, 18, 22
Julella fallaciosa (Stizenb. ex Arn.) R. Harris Common, 14 loc.
Kirschsteiniothelia aethiops (Berk. & Curtis) Hawksw. Rare 15
Lecanactis chloroconia Tuck. Common, 6 loc.
Lecanora allophana Nyl. 3, 16, 21
Lecanora caesiorubella Ach. subsp. *caesiorubella* Common, 12 loc.
Lecanora carpinea (L.) Vain. 6, 16, 18. This species is mainly western in North America with occurrences in northern Michigan (Imshaug & Brodo 1966).
Lecanora cenisia Ach. Rare 1
Lecanora circumborealis Brodo & Vitik. 7, 19
Lecanora dispersa (Pers.) Somm. Rare 1
Lecanora hybocarpa (Tuck.) Brodo 6, 23
Lecanora impudens Degel. Common, 6 loc.
Lecanora muralis (Schreb.) Rabenh. 1, 3, 20
Lecanora pallida (Schreb.) Rabenh. var. *rubescens* Imsh. & Brodo Common, 6 loc.
Lecanora piniperda Körb. Rare 4
Lecanora polytropa (Hoffm.) Rabenh. Rare 6
Lecanora pulicaris (Pers.) Ach. 8, 18
Lecanora rugosella Zahlbr. 11, 14, 19, 23
Lecanora saligna (Schrad.) Zahlbr. Rare 18
Lecanora strobilina (Spreng.) Kieff. 8, 18
Lecanora symmicta (Ach.) Ach. Common, 17 loc.
Lecanora thysanophora R. Harris ined. Common, 16 loc.
Lecanora wisconsinensis Magn. Common, 10 loc.
Lecidea albohyalina (Nyl.) Th. Fr. Rare 15
Lecidea berengeriana (Mass.) Nyl. 1, 7
Lecidea elabens Fr. Rare 8
Lecidea helvola (Körb. ex Hellb.) Oliv. 7, 16, 22
Lecidea plebeja Nyl. 4, 8, 14
Lecidea vernalis (L.) Ach. Rare 3
Lecidella carpathica Körb. Rare 1
Lecidella stigmatea (Ach.) Hert. & Leuck. Rare 1
Lepraria finkii (B. de Lesd. in Hue) R. Harris 5, 13
Leptogium cyanescens (Rabenh.) Körb. Common, 7 loc.
Leptogium lichenoides (L.) Zahlbr. Rare 1
Leptogium saturninum (Dicks.) Nyl. Rare 9
Leptorhaphis epidermidis (Ach.) Th. Fr. 2, 19, 21, 24
Lobaria pulmonaria (L.) Hoffm. Common, 16 loc.
Lobaria quercizans Michaux Common, 10 loc.
Lopadium pezizoideum (Ach.) Körb. Rare 1
Micarea melaena (Nyl.) Hedl. 4, 22
Mycoblastus sanguinarius (L.) Norm. 4, 5
Mycocalicium subtile (Pers.) Szat. Common, 8 loc.
Nephroma helveticum Ach. Rare 23
Nephroma parile (Ach.) Ach. 3, 7
Ochrolechia arborea (Kreyer) Almb. 4, 5, 6, 24
Ochrolechia rosella (Müll. Arg.) Vers. Common, 6 loc.
Opegrapha prosodea Ach. 19, 23. This may be the first record in the Great Lakes Region for this species.
Opegrapha varia Pers. Common, 7 loc.
Pachyphiale fagicola (Hepp ex Arn.) Zw. 6, 21
Parmelia albertana Ahti Rare 24
Parmelia aurulenta Tuck. Common, 9 loc.
Parmelia caperata (L.) Ach. Common, 23 loc.
Parmelia crinita Ach. Rare 17
Parmelia cumberlandia (Gyeln.) Hale 2, 20
Parmelia exasperata De Not. Rare 1
Parmelia exasperatula Nyl. 10, 13, 16, 17, 19
Parmelia flaventior Stirt. Common, 11 loc.
Parmelia galbina Ach. Common, 6 loc.
Parmelia hypoleucites Nyl. Rare 2
Parmelia olivacea (L.) Ach. 2, 6, 10, 19, 23
Parmelia rudecta Ach. Common, 17 loc.

Parmelia septentrionalis (Lynge) Ahti Common, 6 loc.
Parmelia soredica Nyl. Rare 1
Parmelia squarrosa Hale Common, 23 loc.
Parmelia subargentifera Nyl. 2, 3, 6, 16
Parmelia subaurifera Nyl. Common, 20 loc.
Parmelia subolivacea Nyl. in Hasse Rare 18
Parmelia subrudecta Nyl. Common, 17 loc.
Parmelia sulcata Tayl. Common, 20 loc.
Parmeliopsis ambigua (Wulf. in Jacq.) Nyl. 4, 15
Parmeliopsis hyperopta (Ach.) Arn. 4, 15, 18
Peltigera canina (L.) Willd. Common, 7 loc.
Peltigera didactyla (With.) Laund. (Thomson 1946) 11, 19, 21
Peltigera elisabethae Gyeln. 1, 5, 12, 19, 23
Peltigera evansiana Gyeln. Common, 11 loc.
Peltigera horizontalis (Huds.) Baumg. Rare 19
Peltigera lepidophora (Nyl. ex Vain.) Bitter 15, 16
Peltigera malacea (Ach.) Funck Rare 9
Peltigera membranacea (Ach.) Nyl. 5, 7, 10, 19, 22
Peltigera polydactyla (Neck.) Hoffm. (Thomson 1946) Common, 11 loc.
Peltigera praetextata (Flörke ex Somm.) Zopf 6, 7, 9, 19
Peltigera rufescens (Weis) Humb. (Thomson 1946) Rare 15
Peltigera scabrosa Th. Fr. Rare 1
Pertusaria alpina Hepp ex Ahles Rare 1
Pertusaria amara (Ach.) Nyl. Common, 10 loc.
Pertusaria consocians Dibb. Common, 6 loc.
Pertusaria macounii (Lamb) Dibb. (Dibben 1980) Common, 6 loc.
Pertusaria ophthalmiza (Nyl.) Nyl. (Dibben 1980) 5, 7, 12
Pertusaria rubefacta Erichs. Rare 16
Pertusaria velata (Turn.) Nyl. (Dibben 1980) 6, 16, 17
Phaeophyscia ciliata (Hoffm.) Moberg Common, 6 loc.
Phaeophyscia orbicularis (Neck.) Moberg (Thomson 1963) Rare 13
Phaeophyscia pusilloides (Zahlbr.) Essl. 3, 11, 17, 19, 24
Phaeophyscia rubropulchra (Degel.) Moberg Common, 16 loc.
Phaeophyscia sciastra (Ach.) Moberg 1, 15
Phlyctis argena (Spreng.) Flot. Common, 8 loc.
Physcia adscendens (Th. Fr.) Oliv. Common, 7 loc.
Physcia aipolia (Ehrh. ex Humb.) Fürnr. 3, 7, 16, 18, 19
Physcia caesia (Hoffm.) Fürnr. Rare 15
Physcia dubia (Hoffm.) Lett. Rare 15
Physcia millegrana Degel. Common, 6 loc.
Physcia phaea (Tuck.) Thoms. Rare 1
Physcia stellaris (L.) Nyl. Common, 9 loc.
Physconia detersa (Nyl.) Poelt (Thomson 1963) Common, 17 loc.
Placynthiella icmalea (Ach.) Coppins & James 4, 14, 15, 17
Placynthiella oligotropha (Laund.) Coppins & James Rare 17
Placynthium nigrum (Huds.) Gray Rare 1
Platismatia tuckermanii (Oakes) W. Culb. & C. Culb. 4, 5, 22
Porpidia macrocarpa (DC. in Lam. & DC.) Hert. & Schwab Common, 7 loc. Some of the material included here may be moved to other species when reevaluated according to the recent revision of the genus (Gowan 1989).
Protoblastenia rupestris (Scop.) Steiner Rare 15
Pseudevernia consocians (Vain.) Hale & W. Culb. Rare 4
Pseudocyphellaria crocata (L.) Vain. Rare 13. This species was more common in the northern Great Lakes Region in the past, but is now quite rare. There are recent collections in MIN only from northern Minnesota and Isle Royale. This record from Devils Island is apparently the most southern locality in the Great Lakes Region.
Pyxine sorediata (Ach.) Mont. Common, 6 loc.
Ramalina americana Hale Common, 7 loc.
Ramalina dilacerata (Hoffm.) Hoffm. Common, 6 loc.
Ramalina intermedia (Del. ex Nyl.) Nyl. Common, 10 loc.
Rhizocarpon concentricum (Dav.) Beltram. Rare 15. Known also from northern Minnesota, Isle Royale, and Slate Islands, Ontario according to collections in MIN.
Rhizocarpon grande (Flörke ex Flot.) Arn. Rare 2
Rinodina ascociscana Tuck. 6, 17. Apparently an eastern species reaching its western limits in northern Michigan and northern Wisconsin.
Rinodina milliaria Tuck. 2, 18, 20
Rinodina subminuta Magn. Rare 3
Rinodina turfacea (Wahlenb.) Körb. Rare 3. Represented in MIN from the arctic, Isle Royale, and northern Minnesota.

Scoliciosporum chlorococcum (Graewe ex Stenh.) Vezda Common, 9 loc.
Scoliciosporum umbrinum (Ach.) Arn. 1, 15
Sphinctrina anglica Nyl. Rare 8
Sphinctrina turbinata (Pers.) De Not. 5, 9, 23
Staurothele fuscocuprea (Nyl.) Zsch. Rare 20
Stenocybe major Nyl. ex Körb. 5, 15
Stenocybe pullatula (Ach.) B. Stein Rare 24
Stereocaulon paschale (L.) Hoffm. Rare 2
Stereocaulon saxatile Magn. 9, 15, 17
Strigula stigmatella (Ach.) R. Harris 12, 23
Thelocarpon laureri (Flot.) Nyl. Rare 19
Trapelia involuta (Tayl.) Hert. Rare 17
Trapelia placodioides Coppins & James 2, 20. Recently described and distribution uncertain, but collections in MIN from northern Minnesota, Isle Royale, and northern Ohio.
Trapeliopsis flexuosa (Fr.) Coppins & James Rare 20
Trapeliopsis granulosa (Hoffm.) Lumbsch Common, 7 loc.
Trapeliopsis viridescens (Schrad.) Coppins & James Common, 7 loc.
Umbilicaria mammulata (Ach.) Tuck. Rare 1
Usnea cavernosa Tuck. Common, 7 loc.
Usnea ceratina Ach. 4, 5, 13, 22
Usnea filipendula Stirt. 5, 13, 15, 20
Usnea hirta (L.) Weber ex Wigg. Common, 9 loc.
Usnea lapponica Vain. Rare 23
Usnea subfloridana Stirt. Common, 14 loc.
Verrucaria muralis Ach. Rare 15
Verrucaria nigrescentoidea Fink Rare 1
Xanthoria elegans (Link) Th. Fr. 1, 15
Xanthoria fallax (Hepp in Arn.) Arn. Common, 6 loc.
Xanthoria polycarpa (Hoffm.) Rieber Common, 10 loc.
Xylographa opegraphella Will. in Rothr. Rare 18. This may be the first record of this species from the Great Lakes Region.

DISCUSSION OF FLORA

This list includes 271 species collected for this study. There are an additional 12 unidentified taxa in my collections, some of which are undescribed. The most common species are *Cladonia coniocraea, Hypogymnia physodes, Lecanora symmicta, Lobaria pulmonaria, Parmelia caperata, Parmelia rudecta, Parmelia subaurifera, Parmelia sulcata,* and *Physconia detersa.*

The report of the 1965 ABLS Foray (Brodo 1967) includes a number of additional species. There are some vouchers from the ABLS Foray in the University of Minnesota herbarium and some of the species reported by Brodo were found to be misidentifications. Some of the species reported from the ABLS Foray are not known from North America according to the Fifth Checklist (Egan 1987) and others do not occur in the Great Lakes Region. Since it was not possible to borrow all of the specimens the foray reports were based on, and since none of the localities is within the park, these species reports are not included here.

The lichens at different localities in the Apostles are quite variable. On some islands with dense hardwood forests the lichen flora is not diverse but on other islands (especially Devils Island) there are many lichens. The lack of abundant rock outcrops limits the lichen flora significantly. Most of the rock that is available is soft sandstone with only a limited lichen flora. Most of the lichens in the hardwood forests are ones common further south, but on Devils Island numerous northern species occur. Most of the species in the park are also known from northern Michigan and northern Minnesota.

This list of species presents the first listing of lichens for the park and includes some species rare in the Great Lakes Region. The occurrence of

Pseudocyphellaria crocata on Devils Island is especially noteworthy since it probably represents a new southern record for the Great Lakes Region. It formerly was found at several localities along the north shore of Lake Superior prior to 1920, but has been collected in recent times only on Isle Royale (Michigan) and Voyageurs National Park (Minnesota) and reported from the Susie Islands (Minnesota) by Thomson (1954).

The locality with the highest number of rare species is the southern end of Basswood Island around the shore and quarry. This locality is special partly because of the numerous shore rocks and also the shady inland rocks. The second highest number of rare species was found at the northern end of Devils Island. Again, this locality has abundant rocks near the lakeshore but also a good balsam fir forest and has an aspect of the more northern localities found on Isle Royale.

Some of the species found only once are rare wherever they are found throughout their distributional range and might be found at other localities with further searching. Others may require special substrates that are rare in the park. Further collecting on other islands would probably add a few species to this list.

ACKNOWLEDGMENTS

This study originated as an air quality project funded by the National Park Service and this paper is the floristic part of that report (Wetmore 1988). The park personnel have been very helpful during the field work which has contributed significantly to the success of the project. Dr. James Bennett offered suggestions on the field work and the manuscript. The assistance of all of these is gratefully acknowledged.

COLLECTION LOCALITIES

The following is a list of collection localities for this study. The number at the beginning of each locality is cited in the species list.

ASHLAND COUNTY

1. South end of Basswood Island. Along shore around old quarry and campground in hardwood forest with some balsam fir and pines. Sec. 4, T50N, R3W. 1 August 1987.
2. In center of Basswood Island around clearing of old farm (McCloud). Openings with quaking aspen at edge and scattered oaks and maples. Sec. 27, T51N, R3W. 2 August 1987.
3. Hermit Island. On south side near western end near shore in hardwood forest with oak, maple, and birch. Sec. 13, T51N, R3W. 2 August 1987.
4. Stockton Island. Along west side of tombolo north of Presque Isle near stream and bog with black spruce, red pine, and white birch. Sec. 36, T52N, R2W. 4 August 1987.
5. Stockton Island at north edge of Presque Isle. In mixed conifer forest and along bog with *Thuja*, birch, and balsam fir. Sec. 1 & 6, T51N, R1W. 5 August 1987.
6. Manitou Island. On southern tip from shore up to ridge in hardwood forest with maples, birch, and balsam fir near shore. Sec. 24, T52N, R3W. 6 August 1987.
7. Stockton Island, 1 mile east of Quarry Bay. In mixed forest of hardwoods with maples and birch and in low areas with balsam fir and *Thuja*. Sec. 35, T52N, R2W. 6 August 1987.
8. Stockton Island at shore of Julian Bay (north of Presque Isle). In pine stand back from shore with red pines and white pines and juniper. Sec. 6, T51N, R1W. 7 August 1987.
9. South Twin Island between airstrip clearing and ranger station. In mixed forest with birch, maple, *Thuja*, and balsam fir. Sec. 29, T53N, R2W. 8 August 1987.

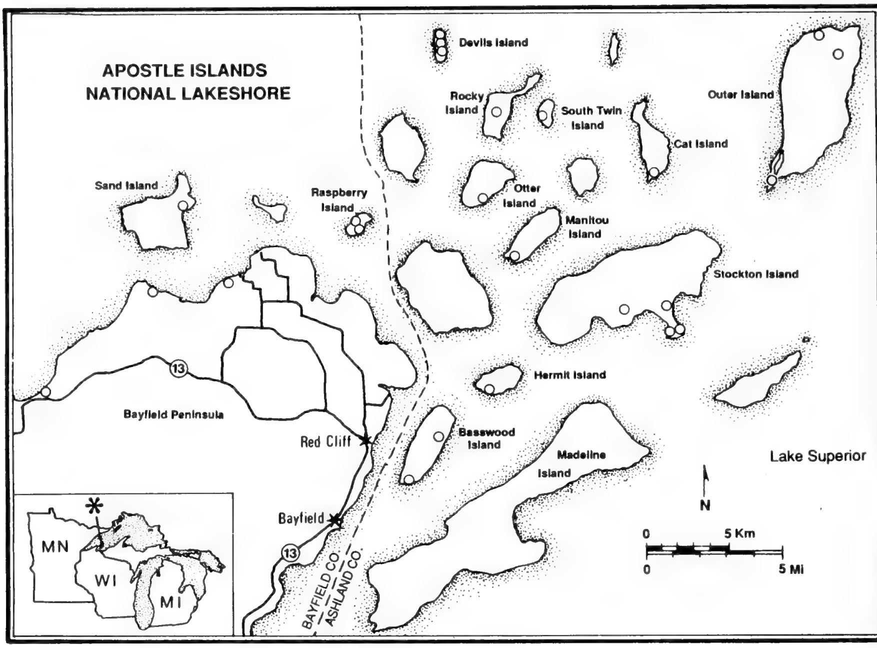

FIGURE 1. Apostle Islands National Lakeshore showing collection localities. Open circles are localities where complete collections were made.

10. Cat Island at southern tip. From shore back into wet area with *Thuja,* birch, yew, and balsam fir and red pines on shore. Sec. 12, T52N, R2W. 8 August 1987.
11. Otter Island at southeastern tip northeast of dock and sand spit. Near shore in mixed hardwood forest and balsam fir and *Thuja.* Sec. 11, T52N, R3W. 8 August 1987.
12. Rocky Island. Inland from dock area on main ridge. In mixed forest of maples, *Thuja,* balsam fir, and birch. Sec. 25, T53N, R3W. 9 August 1987.
13. Devils Island. On high land near southern middle of island east of road. In mixed forest with big, old white pines, birch, and yew. Sec. 10, T53N, R3W. 10 August 1987.
14. Devils Island. On north end of bog near center of island with balsam fir, black spruce, dead snags, and young birch. Sec. 10, T53N, R3W. 10 August 1987.
15. Devils Island. At north end along shore near lighthouse station on rocks and with balsam fir, mountain ash, and white birch. Sec. 10, T53N, R3W. 11 August 1987.
16. Outer Island west of lighthouse. In virgin hemlock stand near shore with hemlock, birch, *Thuja,* and sugar maple. Sec. 13, T53N, R1W. 13 August 1987.
17. Outer Island, 1 mile south of lighthouse. In hardwood forest and wet areas with sugar maple, hemlock, yellow birch, and some *Thuja*. Sec. 18, T53N, R1E. 13 August 1987.
18. Outer Island at southern tip on sand spit. Along shore with jack pines, white pine, and red pine with some maples and birch. Sec. 10, T52N, R1W. 13 August 1987.

BAYFIELD COUNTY

19. Raspberry Island. On west side of island near shore with balsam fir, *Thuja,* and birch. Sec. 19, T52N, R3W. 14 August 1987.
20. Raspberry Island. On building at lighthouse station at southern end of island. Sec. 24, T52N, R4W. 15 August 1987. (Not shown on map).

21. Raspberry Island. Around sand spit and along shore at southeastern part of island with alder, pines, and balsam fir. Sec. 19, T52N, R3W. 15 August 1987.
22. Sand Island. On east side back from shore north of East Bay. At edge of swamp with alder, balsam fir, and birch. Sec. 13, T52N, R5W. 16 August 1987.
23. Mainland, 0.5 miles west of Little Sand Bay Ranger Station. Along shore of Lake Superior with balsam fir, white birch, and hemlock. Sec. 32, T52N, R4W. 18 August 1987.
24. Mainland at Sand Point on shore of Lake Superior. Low area along shore with *Thuja*, white birch, and balsam fir. Sec. 35, T52N, R5W. 18 August 1987.
25. Mainland at Squaw Bay of Lake Superior at western end of park east of Meyers Road. Steep shore and gullies with alder, white birch, and quaking aspen. Sec. 19, T51N, R5W. 18 August 1987.

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REVIEW

THE *WEN*, THE *BOTANY*, AND THE *MEXICAN HAT*. The Adventures of the First Women Through Grand Canyon, on the Nevills Expedition. By William Cook. Callisto Books, Box 113, Orangevale, CA 95662. 1987. 151 pp. $8.75, paperbound.

Were it not for the subtitle, all of our readers might wonder why this volume rates review here. But some will recall that the two women referred to were from the University of Michigan: the late Dr. Elzada U. Clover, who received her Ph.D. in 1935 and continued to teach until her retirement in 1966 (including at the Biological Station in 1954 and 1956–1966), and her student, Lois Jotter (now Cutter). Dr. Clover was one of the founding parents of the Huron Valley Chapter of the Michigan Botanical Club in 1960 and served as its second president; she was also the moving spirit behind the Undergraduate Botany Club at the University. So many of our readers will have seen her motion pictures (and heard her tell) of the thrilling 660-mile trip, spending 42 days in the summer of 1938 on the Green and Colorado Rivers.

Prior to the Nevills Expedition, with its three wooden, motorless boats specially built (and named) for it, only 58 persons had successfully completed the perilous Grand Canyon run (including Major John Wesley Powell, the first, in 1869). Any reader is likely to enjoy this thrilling tale, based on diaries of Elzada Clover and others, interviews with survivors of the trip and with their relatives (including two of Elzada's sisters), and other sources. But those of us who personally knew the indomitable botanist who calmly collected cactus specimens between life-threatening rapids, prepared breakfast for the party, photographed plants and river and canyons, and made fudge for the crew at campsites will especially appreciate this lively telling of the story, with immense detail, obviously the result of laborious investigation. You will learn how the seventh child in the Clover family received her full name (and see a picture of the whole family in 1913) and other tidbits of information. The book is illustrated with several photographs from the trip and a useful map.

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A NEWLY DISCOVERED POPULATION OF SWAMP COTTONWOOD (POPULUS HETEROPHYLLA) IN SOUTHEASTERN WASHTENAW COUNTY, MICHIGAN

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Swamp cottonwood, *Populus heterophylla* L., is one of the rarest trees in Michigan, its known current distribution being limited to two sites, one in Kalamazoo County and one in Washtenaw County (Wagner et al. 1980). In September of 1989, an additional population was discovered approximately 21 km east of the other Washtenaw County site, 0.7 km east of Whittaker Rd. on the north side of Talladay Rd., SE 1/4, SW 1/4, Sec. 15, T4S, R7E, Ypsilanti East quadrangle.

The site is a 20-acre privately owned woodlot, and has been highly disturbed by logging as recently as ten years ago. The soil is mesic to wet-mesic in moisture status and is nutrient-rich. Originally part of a beech-sugar maple forest, the current tree species include many large, old, declining American beech, *Fagus grandifolia* Ehrh., as well as many younger specimens of *Acer rubrum* L., *A. saccharinum* L., *A. saccharum* Marshall, *Carpinus caroliniana* Walter, *Cornus florida* L., *Fraxinus americana* L., *F. pennsylvanica* Marshall, *Juglans nigra* L., *Liriodendron tulipifera* L., *Ostrya virginiana* L., *Populus deltoides* Bartram ex Marshall, *P. grandidentata* Michaux, *Prunus serotina* Ehrh., *Quercus macrocarpa* Michaux, *Q. bicolor* Willd., *Q. rubra* L., *Q. alba* L., *Sassafras albidum* (Nutt.) Nees, *Tilia americana* L., and *Ulmus americana* L. The understory is dense with saplings of these trees, in addition to shrubs such as *Cornus amomum* Miller, *Hamamelis virginiana* L., *Lindera benzoin* (L.) Blume, *Ribes cynosbati* L., *Rubus alleghaniensis* Porter, *R. occidentalis* L., *Sambucus canadensis* L., *Toxicodendron radicans* (L.) Kuntze, *Viburnum acerifolium* L., and *Zanthoxylum americanum* L. *Cephalanthus occidentalis* L. is dominant in and around the edges of the scattered wet depressions.

The population of swamp cottonwood is concentrated in an elongated wet depression roughly 10 m wide and 30 m long with a few trees on adjacent upland. There are 24 trees of diameter of breast height (dbh) greater than 2.5 cm, 11 of which exceed 8 cm, the largest having a dbh of 15.1 cm and a height of about 10 m. About 35 younger trees with dbh less than 2.5 cm also exist. Most of the swamp cottonwoods appear to be in excellent health, and the large ratio of small to large trees indicates good reproduction, most of which is evidently due to root suckering. Having been discovered in the fall, the population has not been observed flowering and as yet the sexuality of individual trees has not been determined.

Shoots from large and small, shaded and exposed plants were collected

and pressed for preservation in the University of Michigan Herbarium (*Pearsall & Wagner 89500*, Sept. 1989). Of additional interest, a rare species of grape fern, *Botrychium oneidense* (Gilbert) House, was found and collected (*Wagner 89501*, Sept. 1989); hundreds of unusually small plants, some of them fertile, were found. The site is currently being marketed as wooded residential lots, and the future of *Populus heterophylla* here is uncertain.

I thank W. H. Wagner, Jr. for his valuable assistance in this study.

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NOTEWORTHY COLLECTIONS

WISCONSIN

RUMEX ACETOSA L. (Polygonaceae). Green Sorrel.

Previous knowledge. Fernald (1950) reported this species as naturalized from Greenland and Labrador to Alaska and British Columbia and southward from New England to Pennsylvania. Voss (1985) noted one collection from Bay City, Michigan in 1897. It is sometimes cultivated as a garden salad green; Vaughn Seed Company, Downers Grove, Illinois, offers seeds of it.

Significance. This species has not been reported for the flora of Wisconsin or other adjacent states except Michigan.

Diagnostic characters. Resembling *Rumex acetosella* L. but much larger, to over 1 m tall, with a tap root, the leaves tufted and cauline, blades oblong and sagittate, fruiting valves 4–6 mm wide.

WISCONSIN. PRICE CO.: Sec. 29 & 32 of T37N, R2E, 19 June 1983 & 8 July 1985, *Alvin Bogdansky s.n.* (UWSP).

The population in 1983 consisted of over 100 individuals on gravelly soil, occurring as an agricultural weed in a degraded pasture and especially as a roadside weed on both sides of county highway D. In 1985, the number of plants was unchanged along the road but had diminished in the fields.

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REVIEWS

WEEDS AND WORDS. The Etymology of the Scientific Names of Weeds and Crops. By Robert L. Zimdahl. Iowa State University Press, Ames 50010. 1989. xix + 125 pp. $19.95.

This little book should encourage people confronting the nation's landfill crisis, when they see how much garbage can be fitted into such a small space. The publisher ought to be acutely embarrassed at issuing this dismal volume without review by someone who knows something of botany, or nomenclature, or languages. The author refers the reader to Stearn's *Botanical Latin* but evidently made no use of it himself. The tome begins with a helpful and pleasant introduction, pointing out how essential names are—even if not meaningful at first glance—so that both friends and enemies may easily refer to what is named. But the work soon deteriorates into a weird mishmash of obfuscation.

Beneath each name of a selected weed or crop plant appears a phonetic pronunciation for the scientific name and a list of Greek, Latin, and other roots or word elements that one is presumably to assume have something to do with the name (though often irrelevant, redundant, or even erroneous). Then there is a paragraph attempting to relate the roots to the name, often involving wild speculation on what Linnaeus or others had in mind. Space forbids a full litany of failure for so noble a purpose. A few examples must suffice. Under *Agropyron repens*, quack grass, are roots for field [wild], for wheat, and for creeping (*repens*)—followed by a Sanskirt *repo* ("related to") and *serpens*, essentially a Latin synonym of *repens* but quite irrelevant here and said to mean "to creep or crawl" (grammatical distinctions such as those between participles and infinitives generally escape the author). We are advised that Linnaeus may have thought "the pink or red basal portions of the plant" in *Allium vineale* resembled red wine; if so, the wine must have been taken internally, since the basal parts of this species are *not* red. At least the epithet *vineale* (meaning of vineyards) is given four syllables, whereas most such epithets are deprived of their final syllable (*arvense*, *vulgare*, *aviculare*, *capillare*, *officinale*, and *halepense* are all truncated, as is the generic name *Glycine*, which we are instructed to pronounce as two syllables, ignoring the elementary rule that in classical languages every vowel or diphthong requires a separate syllable).

The author never seems to realize that sometimes plants were named for a resemblance to another plant rather than with a literal meaning. We are told that the epithet in *Alopecurus myosuroides* "suggests that the spikes resemble a mouse's tail more than any other tail." To anyone not hallucinating, the epithet simply suggests that some aspect of the plant resembles the genus *Myosurus*! Similarly, *Ambrosia artemisiifolia* "suggests an association with forests and hills," of which Diana (Artemis) was the goddess, rather than a more mundane resemblance to the genus *Artemisia*. However, we are assured that the plant does have "many layers of leaves," thus justifying "*-folia*" which is said to be the plural of *folium*, "akin to many layers of leaves."

Under *Barbarea vulgaris* the neuter adjectival form *vulgare* is given (but as a verb "to make known"), followed by *vulgatus* and *vulgus*, all of which is quite superfluous when what's needed is a simple explanation that *vulgaris* (m., f.), *vulgare* (n.) means common. Likewise, why are both *sativa* ("sown") and *sativus* ("that which is sown") given when they are simply different genders of the same adjective? Users who appreciate the scholarly derivations provided in *Gray's Manual*, where the epithet of *Brassica kaber* is explained as a Persian name, will be amused at the alleged derivation from a Greek word for "pole; beam" which "refers to the strong 50- to 10-cm-tall stem" [sic]. Genitives (possessives) rate no recognition as such, so that *theophrasti* means "after Theophrastus" and *sepium* is simply plural for hedge although *Vicia sepium* "is not a hedge-forming plant, but the foliage is as dense as a hedge." Couldn't it just be stated that this is a weed *of* hedges or hedgerows? *Matricaria matricarioides* (Less.) C. L. Porter "was probably considered the type species for the genus, which explains its specific name"; rather, it explains that the author doesn't understand types, or names, or double citation of botanical authors, for which a muddled explanation was attempted on p. xiv. Citing *annua* under *Ananas*, *hypogenous* [sic] under *Arachis*, and *chamai* under *Camellia* contributes nothing but confusion to the reader. While not technically incorrect, it does also confuse to say under *Phragmites* that the epithet *australis* "implies southern, not Australian, origin" since in this case the type locality is indeed Australia. On the same page, *Phalaris arundinacea* is hopelessly confused with *P. canariensis* (nowhere mentioned) as to habit and nativity. After reading of the "achenes" of *Tragopogon*, we are told, in apparent contrast, that each "seed" bears a pappus and "When the pappus is collected together . . . by an involucre of long-pointed, narrow bracts that tend to constrict it, it resembles a goat's beard". The consistency achievable by word-processors is evident when words (e.g. *humilis* and *stratiotes*) are consistently misspelled.

It is a pity that a topic so inherently interesting has been so shabbily treated. As a work of reference, this book is so turgid with errors that students should be protected from seeing it. As a work of humor, it is overpriced.

FLORA OF THE NORTH SHORE OF LAKE SUPERIOR (Vascular Plants of the Ontario Portion of the Lake Superior Drainage Basin). Syllogeus No. 63. National Museum of Natural Sciences, Ottawa, Ontario, Canada K1P 6P4. 1989. 61 pp. $3.95 plus shipping & handling ($2.50 in Canada, $5.00 elsewhere).

After a brief account of collecting history, especially of the five surveys sponsored 1935–1939 by the National Museum of Canada (and conducted by personnel from the University of Toronto), this volume presents a checklist of 1211 taxa, of which 217 are considered introduced. Families are alphabetical within each of the four major groups (pteridophytes, gymnosperms, monocots, dicots) and species are listed alphabetically in each family. For each species there is a habitat code (3 possible letters and 9 numer-

als, explained on p. 11) and (in dizzyingly long columns headed by letters) a record of representation in 9 segments into which the North Shore is divided in a map on p. 12. Thus, there is a very large amount of information, intelligible by constant reference to earlier pages (or with a good memory). For example, "W5678" after *Acer rubrum* means that it grows in wet situations of forest, woodland, shores, and rock exposures and checks in the columns headed W, M, L, & B mean that it is known from the southwestern part of the Thunder Bay District and from areas centered on Michipicoten, Lake Superior Provincial Park, and Batchawana.

A work like this is always an inspiration to field collectors to get out and "fill in the gaps." That includes documenting sight records. To my chagrin, in 1972 I photographed magnificent stands of blooming *Ranunculus gmelinii* near Heron Bay but failed to make specimens, not realizing that they would have extended known occurrence two geographic segments eastward from those indicated here. In 1988, I did document *Carex gracillima*, *C. ormostachya*, *Salix planifolia*, and *Claytonia caroliniana* in Lake Superior Provincial Park—too late to affect this list. On the other hand, the boreal *Juncus stygius* is inexplicably omitted completely from listing, although there are published citations from Batchawana and Peninsula and I have collected it from two widely separated sites in "P" ("Peninsula" = Marathon section) and distributed duplicates between 1964 and 1976 to relevant herbaria (CAN, TRT, LKHD).

This publication is an impressive compilation that will be very useful to all botanists who traverse the beautiful and fascinating region it covers. It is somewhat erratic regarding nomenclature, which "mostly" follows Scoggan's 1978–1979 *Flora of Canada*, with use of "a number of more recent revisions." However, use of published comments on certain names or just of the International Code of Botanical Nomenclature could have made the names more accurate. For example, incorrect gender and authorship are indicated for *Nemopanthus mucronatus*, the illegitimate names *Betula lutea* and *Hypopitys* are used, *Oxycoccus quadripetalus* is attributed to Gilibert (whose names are ruled not validly published), *Amphicarpa* and *Moldavica* are used (although *Amphicarpaea* has been listed as a conserved spelling for 9 editions of the Code and *Dracocephalum* has been conserved nearly as long), *older* names are sometimes cited in the synonymy of adopted ones (*Sonchus uliginosus*, *Aronia melanocarpa*, *Heracleum lanatum*), and *Carex houghtonii* is not the original spelling. Scoggan cannot be blamed for the epithet "*cephalanthii*," an impossible genitive from the name (*Cephalanthus*) of a frequent host for a species of *Cuscuta*.

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On the cover: *Ponds and low dunes near tip of Long Point, Ontario. Photographed by P. M. Catling, 21 September 1979.*

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THE MICHIGAN BOTANIST

May, 1990

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GERMINATION AND GROWTH OF *RANUNCULUS CYMBALARIA*, AN ENDANGERED WETLAND PLANT

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In order to effectively propose management or recovery plans for endangered plant species, basic biological data on life history characteristics and habitat requirements are needed, yet such information is unavailable for many plant species. Here we report on the germination requirements and growth performance of a rare Great Lakes region perennial herb, *Ranunculus cymbalaria* Pursh (Ranunculaceae). The results provide insight into the species' habitat requirements and suggest a potential for greenhouse propagation.

Known as seaside crowfoot or seaside buttercup, *R. cymbalaria* is a small (5–15 cm tall) rosette-form perennial with long-stalked leaves with smooth, waxy reniform blades. It produces long stolons that root readily, and from these stolons arise flowering scapes with 1–10 yellow-petalled flowers that produce cylindrical clusters of tiny, dry achenes. Considering its three varieties (Kartesz & Kartesz 1980), the species has a broad, circumboreal range, although its occurrence is local and erratic throughout (Porsild 1964, Bowles et al. 1981, Rickett 1966 & 1970). In North America, it ranges across Canada and down the Pacific coast to Mexico and beyond to South America, but is apparently absent on the Atlantic coast south of New Jersey. While predominantly coastal, it also has an island distribution that includes the Southwest, Texas, Arkansas, and the western Great Lakes region. It appears to be a salt-tolerant plant of saline and brackish shores; inland, it is found mainly in "springy", alkaline marshes and mudflats (cf. Catling & McKay 1981).

Loss of suitable shoreline habitat is the probable reason that the species is now relatively rare in the Great Lakes States; it is endangered in Wisconsin (Wisconsin Dept. of Natural Resources records) and Illinois (Bowles et al. 1981) and was recently proposed for endangered status in Michigan (Beaman et al. 1985). In Wisconsin, it was apparently more common along the Lake Michigan shoreline until the early 1900's, as evidenced from a number of collection records; however, there are now only two localities in the state with recent records of occurrence (Wisconsin Dept. of Natural Resources records). Seeds used in this study were obtained from a naturally-occurring population in the city of Green Bay, Brown County WI, in a marsh adjacent to Interstate 43, where there is substantial de-icing salt runoff.

METHODS

In September 1988, mature seeds were collected from the *R. cymbalaria* population in Brown County, WI (courtesy of the Wisconsin Dept. of Natural Resources). Seeds were stored dry in a sealed vial at room temperature until the experiments were started in late October. For each germination replicate, 50 seeds were placed in Parafilm®-sealed petri dish on a layer of white sand saturated with deionized water. Germination trials were conducted in controlled-environment chambers under three temperature conditions: a constant 5°C and two 12/12 hr thermoperiods of 20/10°C and 25/15°C, respectively. All "light" trials were exposed to a 14/10 hr photoperiod under cool white fluorescent light (range 70–100 $\mu E/m^2/sec$), with the light cycle timed to begin one hour before the onset of "day" temperatures. "Dark" germination was achieved by wrapping the plates with two layers of aluminum foil. Two replicate plates were exposed to each combination of temperature and light condition for a two-week period, after which all plates were examined for percent seed germination. Additional prepared replicate plates were wrapped in aluminum foil and subjected to moist, cold stratification at 5°C for one and two months, respectively. After the appropriate stratification time, germination trials were repeated as above at the two higher-temperature thermoperiods, with two replicates unwrapped ("light") and two left wrapped ("dark") at each thermoperiod.

To assess the potential for indoor propagation, two- to four-week old seedlings were transplanted singly from the petri plates to pots filled with a soilless greenhouse mix. One set of these transplanted seedlings was placed in a greenhouse, with one group of pots ("Dry1") being permitted to drain freely after watering, and another group ("Wet1") kept in about 3cm standing water. To assess whether propagation success could be improved if young seedlings were protected from dessication, a second set of potted seedlings was kept in a covered glass container in the 25/15°C environmental chamber for an additional four weeks before being transferred to the two greenhouse conditions (groups "Dry2" and "Wet2"). Plants in the greenhouse were lightly watered daily, and those in the chamber watered more thoroughly biweekly. All were fertilized weekly. Growth measurements of the total number of leaves and the width of the largest leaf were made on all plants monthly, and the production of runners and flowering scapes noted.

RESULTS AND DISCUSSION

Germination of *Ranunculus cymbalaria* is affected both by temperature and by light (Table 1). There was a complete absence of germination in the dark, regardless of temperature or length of stratification (at least to two months). Unstratified seed apparently requires high temperatures for any significant germination; stratification appears to lower the temperature threshold for germination response as demonstrated by increased germination success at the lower temperature. Regardless of the stratification period, higher temperatures produced greater germination. These responses suggest that seed produced in the field in mid-summer might germinate during the same year, while seed produced later in the season, when it is cooler, might overwinter to germinate in the following spring.

The plants are easily grown in the greenhouse under non-saline conditions (Fig. 1). Plants that were kept in a humid container in the growth chamber before being moved to the greenhouse ("2" groups) achieved better growth than seedlings transferred earlier ("1" groups). Among the former group, some individuals produced runners and flowers at age four months.

TABLE 1. Germination responses of variably-stratified *Ranunculus cymbalaria* seed in relation to light and temperature conditions during germination.

Cold stratification period (months)[1]	Light condition	Germination temperature (°C day/night)	Percent seeds germinated (mean ± s.e.)
0	dark	5/5	0
		20/10	0
		25/15	0
	light	5/5	0
		20/10	1 ± 1
		25/15	33 ± 5
1	dark	20/10	0
		25/15	0
	light	20/10	12 ± 6
		25/15	66 ± 6
2	dark	20/10	0
		25/15	0
	light	20/10	48 ± 4
		25/15	82 ± 10

[1]moist stratification at 5°C

Flowering and stolon production may require a minimum size of around 30 leaves, as four-month old plants of smaller size did not flower. Keeping the pots in standing water ("Wet" groups) also improved growth, perhaps because of greater retention of fertilizer and also reflecting the plant's preference for wet areas. Although we have not made further growth measurements, the plants have continued vigorous growth, runner production, and flowering in the greenhouse.

It has been noted that *R. cymbalaria* appears intolerant of shading and is thus generally associated with open, disturbed environments that have reduced cover of other plant species (Fewless 1989). That vigorous growth can occur in a non-saline medium suggests that the "halophytic" character of this species is one of tolerance of saline conditions rather than a requirement for them, and this trait permits the species to persist in habitats too harsh for other plant species. The light requirement for germination further suggests a "weedy" habit favored by disturbances that would expose seeds to high insolation. The "weedy" characteristics of *R. cymbalaria* suggest the scenario that, prior to European settlement of the Great Lakes area, the species existed as an ephemeral dependent upon an abundance of naturally-disturbed shoreline sites and/or harsh alkaline habitats with low cover of other plant species. At present, however, extensive development and loss of shoreline appears to have largely eliminated these types of habitats and led to the decline of *R. cymbalaria*.

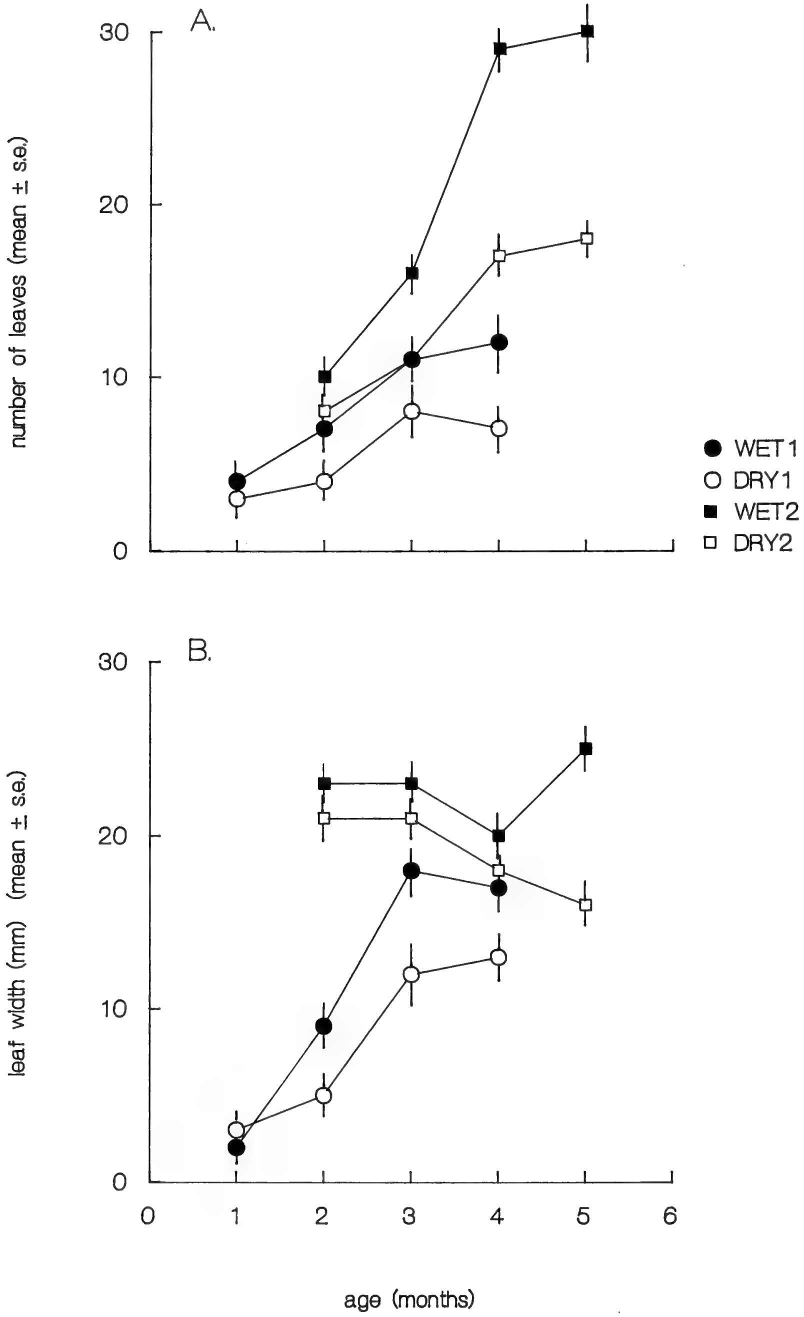

Fig. 1. Growth of *Ranunculus cymbalaria* seedlings grown under varying greenhouse conditions; see methods for description of "Dry" and "Wet" treatments. A. Number of rosette leaves. B. Size of largest leaf. Sample sizes: "Wet1"= 5, "Dry1" = 4, "Wet2" = 6, "Dry2" = 6.

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√ REVIEW

PLAIN OL' CHARLIE DEAM, PIONEER HOOSIER BOTANIST. By Robert Kriebel. Purdue University Press, Building D, South Campus Courts, West Lafayette, IN 47907. 1987. x + 183 pp. $12.95, paper.

When I was a young man, not yet a botanist or intending to become one, I sent Charlie Deam a specimen of *Tribulus terrestris* L., new to Indiana (from St. Joseph Co.). He wrote me in return a long and, in the main, complimentary letter, great for my ego, but also let me know that my specimen was virtually pulverized in the mail and therefore worthless! However, it was an accomplishment to find anything in Indiana, in any of its counties, that Deam had not already found, and this is evidenced by his excellent *Flora of Indiana* based on years of his own diligence in collecting. Of course, my *Tribulus* was only a weed that got itself across a state line!

Deam was a business man, a druggist, successful enough that he could devote most of his time to botany, in which he was self-taught. He served as State Forester for a few years, but most of his botanical activities were self-motivated and self-financed. They resulted in a remarkable private herbarium now kept at Indiana University. (His collections from Mexico and Guatemala are at the University of Michigan.) He published, in addition to the *Flora,* admirable book-length treatments of the shrubs, trees, and grasses of Indiana. The author of this racy and amusing account of his life gave ample credit to this plain old Hoosier and his "great, great

wife, who played a congenial and harmonious second fiddle." (Originally a red head, she came to look "like a dandelion gone to seed," owing to a great pile of white hair.) This book was intended as a pressed out literacy specimen "so that anyone can laugh and cry and learn" from the life of this extraordinary man of great achievement. It is good botanical history, very well written, although some details are of trivial interest (county records of undistinguished plants, for example), and some are not entirely accurate (Agnes Chase was at the Smithsonian, not Harvard, and Fred Hermann and Eileen Erlanson were graduates students at the University of Michigan, not professors.) In spite of that very minor criticism, I give the book very high praise indeed. It gives good insights into the work of other Hoosier botanists, Weatherwax, Friesner, Just, Welch, and others (including the author's father).

This Charlie Deam, described as "intense, irascible, opinionated, and hilarious," was one of those "old independent cusses who stomp into town from the country but soon quit school, too smart to stay interested. About age forty, they catch fire on their own, then start rolling, . . . —achieving amazing things that only they really understand; teaching the teachers; working alone mostly; shaking off admirers; tolerating society, mediocrity, laziness, each generation, and Father Time; and defying the Grim Reaper every step of the way." His success as a merchant is attributed to honesty, cleanliness, efficiency, discipline, intelligence, and a bit of common sense and cleverness. His distinction as a botanist can be attributed to many of these same reasons.

This man was indeed eccentric. He considered himself just an old hog rootin' around with the boys, as mine run, plebean born. Margaret Fulford (hepaticologist) once told me that he locked his keys in his car while out collecting; rather than waste time, he picked up a rock and broke a window. Another time, a botanical visitor was unnerved when he took a loaded pistol from a desk drawer and, cursing, fired three shots out the window at a rabbit nibbling on a plant in his garden of native species.

I highly recommend this book, interesting in botanical detail and fun for anyone. (There is a naughty irreverance that I enjoy.)

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OLIVER A. FARWELL'S EARLY PTERIDOPHYTE RECORDS FROM THE KEWEENAW PENINSULA

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INTRODUCTION

Oliver A. Farwell was born in Dorchester, Massachusetts in 1867. While he was a young boy his family moved to the Keweenaw Peninsula in northern Michigan. There he was encouraged by his high school teacher, F. E. Wood, to study botany (Wells & Thompson 1973). Farwell studied at the State Normal School (now Eastern Michigan University) for several years beginning in 1890. The collections discussed in this paper were, for the most part, made before 1890. In 1892, Farwell began working for the pharmaceutical firm of Parke, Davis and Co. in Detroit as a drug inspector, librarian, and botanist. He continued to visit the Keweenaw area on vacations and upon his retirement in 1933 returned there to live. He died in 1944 at the age of 77.

Farwell appears to have been very active in botany at an early age. In 1890, Liberty H. Bailey published a list of 64 species of *Carex* sent to him by Farwell from the Keweenaw (Bailey 1890). Farwell also sent his first specimens to the Gray Herbarium in 1890. Later he (Farwell 1894) named *Cardamine pensylvanica* Willd. var. *brittoniana* Farw. with the inscription "Dedicated to my friend Dr. N. L. Britton . . ." Farwell is cited by Beal & Wheeler (1891) as having provided a list of plants for their *Michigan Flora.* Farwell was actively corresponding and exchanging specimens with M. S. Bebb, J. M. Coulter, G. H. Hicks, J. K. Small, S. Watson, and other members of the Gray Memorial Society at around this time. In 1890, his personal herbarium is known to have contained material from the Keweenaw Peninsula, southern Michigan, the Carolinas, and New York. Beal (1905) acknowledged Farwell for supplying a ". . . full list of plants of the Keweenaw peninsula, Ypsilanti and Detroit, with copious notes and many specimens."

The herbarium of Parke, Davis and Co. was donated to the University of Michigan (MICH) in 1933. It contained approximately 3000 Farwell specimens (McVaugh 1952). There are also about 200 specimens of Farwell's in the herbarium of Eastern Michigan University; these are mainly duplicates of his early collections probably donated while he was a student there. Farwell's personal herbarium was willed to the Cranbrook Institute of Science (BLH) in November of 1944; it arrived in orange crates, largely unmounted, in the original field newspapers, and often with only cryptic labels on scraps of paper (McVaugh et al. 1953). Dale Hagenah was one of the volunteers who worked on mounting, accessioning, and sorting the

15,000 numbers received. Hagenah's personal correspondence provides some insight into the condition of the collection: "It has been suggested that Farwell might have accidentally exchanged or mixed specimens with his Keweenaw material. Having worked with the herbarium soon after it was received at Cranbrook I can see how this might be true" (letter to F. J. Hermann, May 6, 1970). Once when responding to a question on the existence of a particular Farwell specimen Hagenah wrote, "There is a possibility that the specimen could not be associated with the number due to the loss of his little data scrap" (letter to E. G. Voss, April 2, 1971).

The labels on some of Farwell's early specimens are puzzling. There are labels which have dates that are not proper for the flowering or fruiting condition of the plant, or have date or location changes. Some have two dates on the same label or two separate labels. A few have labels glued upon labels. Farwell maintained a catalog of his specimens, and many of his questionable specimens are grouped on a particular catalog date. Early in his catalog, specimens seem to be in loose taxonomic groups (e.g. several ferns, or orchids, or *Carex* together). Sometimes the date in the catalog is the same as the label date, so it could be a collection date. Frequently, however, it is a later date so it might represent an accession date; sometimes the catalog date is earlier, perhaps representing the day a plant was first found, with specimens being gathered later. Among Farwell's material at Eastern Michigan University there are specimens which have dates that differ from the duplicates in his personal herbarium. It appears that the Eastern Michigan University material was labeled with information from his catalog, but without reference to his personal specimens.

Having established this background on Farwell's life and botanical work, a discussion of some of his particularly important pteridophyte records is now in order. Herbarium abbreviations given below follow Holmgren et al. (1981).

ASPLENIUM MONTANUM WILLD. MOUNTAIN SPLEENWORT
ASPLENIUM RUTA-MURARIA L. WALL RUE

Farwell's material of *A. montanum* at BLH is labeled as coming from "Rocky bluffs in Keweenaw Co. rare, Sept. 20, 1888" (*Farwell 706a*). The material at MICH was part of G. H. Hicks' herbarium originally given to Denison University and is labeled "Copper Harbor, Augs 1888, Coll. O. A. Farwell." It had been originally identified as *A. ruta-muraria*. The sheet of *A. ruta-muraria* at BLH bears two labels. One reads "Herbarium of O. A. Farwell 706, *Chamaefilix ruta-muraria* (L) OAF var. *Brunfelsii* (Heuph) OAF, Clifton, Mich, Sept. 20, 1888, among rocks on bluffs rare." The other label reads "Flora of Keweenaw Co. Mich., *Asplenium ruta-muraria* L., Bluffs rare 1889 [sic] No 706."

Besides the aspleniums, Farwell also recorded in his catalog from Sept. 20, 1888 *Carex davisii* Schwein. & Torrey, *C. jamesii* Schwein., *C. lurida* Wahlenb., *C. squarrosa* L., *C. virescens* Willd., *Thelypteris hexagonoptera* (Michaux) Weath., and *Dennstaedtia punctilobula* (Michaux) T. Moore.

Asplenium montanum is listed as "a rare and unaccountable introduction(?)." The *Carex* specimens in question have been rejected by Hermann (1951) and by Voss (1972) on phenological and phytogeographical grounds. Hermann (1951, p.484) also stated, "Farwell's known unmethodical habits in preserving and labeling his specimens . . . lead to the unavoidable suspicion that the labels in question were mixed."

Farwell (1905) wrote, ". . . *Asplenium montanum* Willd. was collected in Keweenaw Co. along with *A. ruta-muraria* L. which is far out of the generally accepted range for this plant." Later Farwell (1937) stated, "The last two species [*A. montanum* and *A. ruta-muraria*] I found mixed in with an old collection of *Woodsia ilvensis*, not knowing at the time that I was getting other than the *Woodsia*. I have not found them since." Some years after visiting Farwell in Keweenaw County, Edgar T. Wherry (1953) wrote, "He showed us [Wherry and Leeds] his specimens of the several disjunct taxa, but was unable to furnish us definite directions for seeking them out for ourselves. We particularly wished to see the otherwise Appalachian *Asplenium montanum*. But Mr. Farwell related how he had gone to 'The Cliff' to collect some *Woodsias* to send to a correspondent, and placed the specimens of these in a vasculum for the trip home. The next day, when he lifted the material out, behold, mingled with the *Woodsias* were some fronds of *Asplenium montanum*. And he never was able to relocate his exact collecting spot. One cannot help wondering whether the *Aspleniums* may not have been received from an eastern collector, and had been lying in the vasculum into which the Michigan ferns were placed."

The Keweenaw record of *A. montanum* was accepted by Fernald (1950) and is the subject of a rather lengthy discussion in Fernald's paper *Critical Plants of the Upper Great Lakes of Ontario and Michigan* (1935).

As is well known, *A. montanum* is a plant that grows on acidic rocks while *A. ruta-muraria* prefers to grow on limestone (Wherry 1961). It seems highly unlikely that the two species would be found growing in close proximity or that *A. ruta-muraria* would be associated with *Woodsia ilvensis*, which does not grow on limestone (Wherry 1961).

The only unquestionable Michigan material of *A. ruta-muraria* was collected by Douglass Houghton on Drummond Island in Chippewa County (MICH). This station was rediscovered by Jarl K. Hiltunen in 1961 (Hiltunen 1962).

DENNSTAEDTIA PUNCTILOBULA (MICHAUX) T. MOORE HAY-SCENTED FERN

Farwell recorded this species (*705*, BLH, ILL) from Sept. 20, 1888, "at Clifton, in rich woods rare." The *Dennstaedtia* is among nine questionable records from Sept. 20, 1888 (see list above under *Asplenium*). Farwell cites this species in his 1937 report on Keweenaw ferns without comment.

There is also a specimen of *D. punctilobula* from G. H. Hicks' herbarium (donated to Denison University: now at MICH), but it has clearly suffered from mislabeling. Farwell is known to have exchanged specimens

with Hicks, and it is likely that the specimen came from Farwell. It is labeled as "*Cystopteris fragilis*, Owosso, Mich. June 17, 1889 Coll. G. H. H[icks]." The specimen has a Denison University label in an unknown handwriting, probably that of a student there. Hicks used preprinted labels bearing his name and his address, Owosso, Michigan. The original label has been transcribed for some reason and it is possible that Owosso was used as the collection locality by mistake. The specimen in question has mature sori though it would probably not have been in that condition so early as the middle of June. This specimen is not included in Beal's flora even though Beal examined Hicks' herbarium (Beal 1905) and Hicks was employed by the Michigan Agricultural College at the time the flora was being written.

The only authentic material from the state is a collection from Jackson County in 1954 by Warren H. Wagner Jr. (BLH). The specimen came from a colony of immature plants. Wagner regarded this population as transitory (Wagner 1972). The recently reported Wisconsin station (Peck & Taylor 1980) was also transient and has now disappeared (Peck, pers. comm., 1990).

THELYPTERIS HEXAGONOPTERA (MICHAUX) WEATH. BROAD BEECH-FERN

This specimen (*707*, BLH) was collected in "Keweenaw Co. under oaks infrequent" on Sept. 20, 1888. In a discussion of the specimen, Hagenah (1955) stated; "In 'Ferns of Michigan' this species was recorded from Keewenaw County on the basis of an O. A. Farwell collection. The preceding species [*Thelypteris phegopteris* (L.) Slosson] was recorded for Oakland County on the basis of another Farwell collection. No confirming collections by other botanists are known. It would seem that these two records, each far from the normal range of the species, may possibly be due to an accidental interchange of specimens by their collector." In addition, the *Thelypteris* was collected on the same date as the questionable *Carex* spp., *Asplenium* spp., and the *Dennstaedtia* discussed above. Recent northern collections of *T. hexagonoptera* have been made in Gogebic County, Michigan (*Voice, Hix, & Spies 80042*, BLH, MICH) and Vilas County, Wisconsin (Peck & Taylor 1980).

POLYSTICHUM ACROSTICHOIDES (MICHAUX) SCHOTT CHRISTMAS FERN

The specimen of Farwell's No. 711 at BLH is labeled "Clifton, Mich. Aug. 20 1889 in rocky woods." This species is not known in Michigan north of Antrim County or in Wisconsin north of the Door Peninsula (Peck & Taylor 1980), distances of approximately 220 and 175 miles respectively.

EQUISETUM TELMATEIA SUBSP. BRAUNII (MILDE) HAUKE GIANT HORSETAIL

Sterile material of this species (*808*, BLH, GH) was collected on August 25, 1890 and fertile shoots in June, 1895. Marquis and Voss (1981, p. 60)

discussed this specimen at length: "Farwell collected it in Keweenaw County, Michigan, in 1890 and 1895 (if the labels be trusted) and there are early reports from New York. These are regarded with suspicion, but not outright rejection, by Hauke (1978). Farwell (1905) stated the plant to be very rare in Keweenaw County and described the situation realistically: 'I know of but one place where it is to be found. This is in an alder thicket and the ground is generally moist and of a rich muck. The sterile fronds in summer are often three feet high and have a spread of branches often measuring two feet.' Later (1937) he merely said 'I have not been to the station since and do not know if it is still there.' Apparently it aroused no phytogeographical curiosity on his part, and no one who has searched for it since has been able to relocate it."

In defense of Farwell it should be noted that the fifth edition of *Gray's Manual* (Gray 1867), which was in use at the time Farwell found this species, includes *E. telmateia* from the "Shore of the upper Great Lakes and northwestward:rare." This may be why it ". . . aroused no phytogeographical curiosity on his part (Marquis & Voss 1981). The species is not listed in the 6th (Watson & Coulter 1890) and 7th (Robinson & Fernald 1908) editions of *Gray's Manual* but is included in the 8th edition (Fernald 1950) solely on the basis of Farwell's material. Edgar T. Wherry tried to visit the Keweenaw station after getting directions from Farwell. In a letter to Hagenah, Wherry stated: "The *Equisetum telemateia* place had been cut over and grown up in impenetrable brush."

Although Beal (1905) cited Farwell for eight other taxa of *Equisetum* from Keewenaw County, he did not include *E. telmateia*. Perhaps this was an oversight on either Beal's or Farwell's part. It seems unlikely that, given Farwell's interest in pteridophytes, this species would be left off his list, if it was indeed part of his herbarium in the early 1900's. It is possible that Farwell purposely did not include this species, wishing to publish an account of its discovery on his own. However, he sent all his other pteridophyte records to Beal and published no special note on this specimen, merely including it in his 1905 general paper cited above.

The only other specimen of *E. telmateia* reported to come from the eastern United States is a specimen labeled by Douglass Houghton as *E. hyemale* from New York state (MICH). This sheet is a mixed collection, with the upper part being *E. telmateia* and the lower part being *E. hyemale*. It probably represents an error in mounting, with the *E. hyemale* part belonging on the sheet.

LYCOPODIUM ALPINUM L. ALPINE CLUBMOSS

Farwell's label for this specimen (*849*, BLH, US) reads "Collected 30 June 1895 on shores of Montreal River Keweenaw Co." This area is further east in the Peninsula than Farwell usually collected. Farwell reported the species promptly (Farwell 1896), stating "Several interesting plants were found growing here [Copper Harbor, Keweenaw County], among them *Lycopodium alpinum* . . ." Also Farwell (1917) gives this description of the

plant: "The stems are close to the surface; leaves unequal, ascending, in 4 ranks; spikes sessile. Keweenaw Peninsula, No. 849, June 30, 1895. Rare."

Wilce (1965) in her monograph on *Lycopodium* does not mention the species from Michigan although she examined the material at BLH and US. *Lycopodium alpinum* is stated to be disjunct in the upper peninsula of Michigan by Lellinger (1985) and is noted from Keweenaw County by Morton (in Gleason 1952) and by Beal (1905).

DISCUSSION

It can be difficult to interpret what a collector had in mind almost 100 years ago. Our own feelings are to accept specimens and their data at face value unless there is significant evidence available to the contrary (i.e. many questionable records grouped on one day, dates not matching condition of specimens, questionable numbers, etc.). There seems to have been no reason for Farwell to have deliberately changed records. Given the size and condition of his herbarium, accidental mix-ups could easily have taken place. Also, Farwell sometimes gave his own collection numbers to plants collected by other people. Many of the questions that have arisen over Farwell's early work may come from the fact that he was a young botanist who had not yet had direct contact with many other botanists or an herbarium. Most of his questionable specimens came from before his studies at Eastern Michigan University; his record keeping seems to have improved after this time.

We must also consider the possibility that some of these species may have been very rare in the Keweenaw and have since become extinct there. The Keweenaw Peninsula is a region of interesting geology and diverse habitats. It is now recognized (Wells & Thompson 1974, Marquis & Voss 1981) that many Western disjuncts and rare plants can be found there, including some originally collected by Farwell. But despite evidence in favor of some of Farwell's early records, it seems highly unlikely that after several years of collecting on the Keweenaw Peninsula he would find in one day eight species that are primarily Appalachian in range. The two *Aspleniums*, the *Dennstaedtia*, the *Thelypteris* and the *Carex* all fall into this group, and are rightly regarded with suspicion.

Based on the fact that the two *Asplenium* species grow on different rock types, that the collector himself said that he never noticed the plants in the wild and could not relocate them, and the fact that a number of other suspicious plants were also collected on the same date, we would reject both of these records. Farwell's *A. montanum* specimen is the only one reported from Michigan, and the plant should be removed from the state flora.

Regarding the *Dennstaedtia*, we feel that the Keweenaw specimen should not be accepted for several reasons. It was collected on the same day as other questionable material, and a species that is only transitory in southern Michigan and in southern Wisconsin would not grow as far north as the Keweenaw.

The *Thelypteris* specimen appears to represent accidental interchange of material by Farwell. Also, it too was collected on the same day as the other questionable material.

As for Farwell's record of *Polystichium acrostichoides*, there is no convincing evidence to accept this record. It should be regarded with suspicion and placed with his specimens of *Cypripedium candidum* Willd., *Carex blanda* Dewey, *C. normalis* Mackenzie, *Panicum perlongum* Nash, *Cinna arundinacea* L., and others which are only credited to the Keweenaw on the basis of Farwell specimens and have been rejected by Voss, Hermann and others on phytogeographical grounds.

We are inclined to accept Farwell's record of *Equisetum telmateia* with reservations. The site was visited twice (1890 and 1895) and both sterile and fertile material was collected. Farwell provides a lengthy habitat description for this plant, and the range of this species also parallels several other disjunct species from the western United States. Despite this, other problems remain. There are no unquestionable *E. telmateia* specimens from the eastern United States, and old literature records were sometimes wrong and merely copied on from one source to another.

We would also accept the record of *Lycopodium alpinum*. Several other vascular plants which are primarily boreal in range also come south into the Keweenaw Peninsula, so this record seems entirely possible. Also, this specimen was not collected with Farwell's very early questionable specimens, but some years later.

SUMMARY

Seven early pteridophyte records of Oliver A. Farwell from Keweenaw County, Michigan, are considered. Herbaria, personal catalogs, and literature records are examined. *Asplenium montanum*, *A. ruta-muraria*, *Dennstaedtia punctilobula*, *Polystichum acroctichoides*, and *Thelypteris hexagonoptera* records are rejected. The record of *Equisetum telmateia* is accepted with caution, and the record of *Lycopodium alpinum* is considered valid. Some other records of these species are also discussed.

ACKNOWLEDGMENTS

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A PACIFIC NORTHWEST DISJUNCT, DISPORUM HOOKERI, IN UPPER MICHIGAN

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INTRODUCTION

There are a number of western disjunct plant species, of different patterns, known to occur in the Great Lakes region (Marquis & Voss 1981). Perhaps the rarest taxon of this group is *Disporum hookeri* (Torrey) Nicholson. In 1968 a single specimen of var. *oreganum* (S. Watson) Q. Jones was collected by P. W. Thompson (*Thompson M-1593*, 30 May 1968, BLH) in Porcupine Mountains Wilderness State Park (Voss 1972), in western upper Michigan. Subsequently, repeated attempts by the original collector and other botanists were unsuccessful in relocating the taxon, and its continued occurrence in Michigan had become doubtful (E. Voss, pers. comm., D. Henson, pers. comm.).

Disporum hookeri, which has been officially listed as Threatened in Michigan since 1976, is currently being considered for change to Endangered status, now that its existence and rarity in the state have been confirmed (E. Voss, pers. comm.).

DISTRIBUTION AND HABITAT

I rediscovered *D. hookeri* var. *oreganum* at a new station in Porcupine Mountains State Park (Sec. 20, T50N, R44W), Ontonagon County, on 6 May 1987 while conducting field work for a continuing forest ecology study (Mladenoff 1985, 1987, in press). Only one flowering individual, approximately 5 dm in height, was located. Positive identification was made during a return visit in June 1987, when the plant had immature fruits. A collection of a portion of the above-ground plant was made on 3 July 1988 (*Mladenoff 01688*, MICH). Additional plants were not found during several additional searches in the vicinity during July 1988. A systematic traverse of several square kilometers of similar habitat in August 1988 resulted in a second station being located, again with only one specimen. A portion of the browsed individual was collected on 9 September 1988 (*Mladenoff 04788*, MICH). This second site, also in the Park, was located approximately 1.5 km from the first station, in Sec. 17, T50N, R44W, Ontonagon County.

Location and habitat of both stations are similar. Both sites are far removed from existing roads or trails, in old-growth forest of eastern hemlock (*Tsuga canadensis* (L.) Carrière) and sugar maple (*Acer saccharum* Marshall), with *Gymnocarpium dryopteris* (L.) Newman, *Maianthemum canadense* Desf., *Viola* spp., *Lycopodium lucidulum* Michaux, and *Dryopteris carthusiana* (Villars) H. P. Fuchs as important herb layer associates. The forest vegetation surrounding the first site is described quantitatively in Mladenoff (1985, in press).

The contiguous range of the species in the Pacific Northwest extends from the central Oregon Coast Range and Cascades north through Washington into British Columbia; in the Rocky Mountains of southern British Columbia, northern Idaho, and northwestern Montana, and down to the Blue Mountains of northeastern Oregon (Fig. 1). This range encircles, but apparently avoids, the dry Columbia River Basin of eastern Washington and Oregon. Within that region it occurs in a variety of habitats and elevational locations, from mesic to moist upland forest sites at low elevations dominated by western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) and Douglas-fir (*Pseudotsuga menziesii* (Mirbel) Franco) in western Oregon and Washington, to the more varied montane forests of the Cascade and westernmost Rocky Mountains (Franklin & Dyrness 1973).

DISCUSSION

Identification of *D. hookeri* var. *oreganum* is not difficult, and it is easily distinguished from other species within the Lake Superior region (no other species of *Disporum* is known to occur). However, because of its unexpected occurrence it may be initially confusing. *D. hookeri* is easily overlooked among its superficially similar forest understory associates of the Liliaceae, such as *Streptopus*, *Polygonatum*, and *Smilacina*. Greatest confusion may arise when encountering the taxon is unexpected and an eastern regional flora is being used, which will take one down to the genus *Disporum*, but which will clearly lack the correct species.

The most distinguishing characteristics (Fig. 2) are its upright, branched, pubescent stems, each terminating in an inflorescence of usually two pendant, creamy-white flowers. Fruits are pubescent berries turning red in late summer to fall. The strongly-veined leaves are sessile and somewhat clasping, especially on the lower stems. The leaves have a thin, papery texture and dull upper surface, unlike the fleshy quality of *Polygonatum pubescens* (Willd.) Pursh or the tougher character of leaves of *Smilacina racemosa* (L.) Desf. and *Streptopus roseus* Michaux.

Given the apparent extreme rarity of *D. hookeri* var. *oreganum* in our region, it is interesting to consider further the nature of its existence in Michigan. Marquis and Voss (1981) described the ranges of the known western disjuncts in the Great Lakes region. Besides having the lowest number of known individuals of the western disjuncts in the Great Lakes, this taxon is also in the most extreme category in terms of disjunction, since

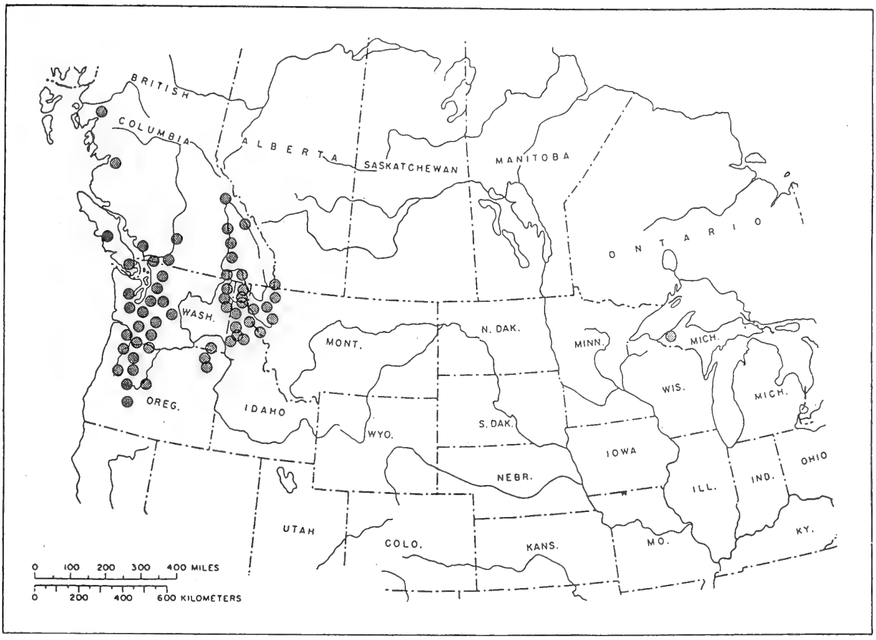

Figure 1. Distribution of *Disporum hookeri* var. *oreganum* in the Pacific Northwest and disjunct in Michigan. Pacific Northwest occurrence data redrawn from Jones (1951).

it occurs neither in the Black Hills of South Dakota nor farther east in the St. Lawrence valley (Marquis & Voss 1981). Several theories have been proposed to account for these discontinuous species ranges, beginning with the "nunatak," or high elevation glacial refuge, hypothesis (Fernald 1925), which has been discounted (Marquis & Voss 1981). The other two major theories of the origin of these disjuncts rely on hypothesized responses to past glacial activity, and either subsequent migration into habitat along the receding ice margin from western origins, or reinvasion from refugia following a formerly continuous, continental distribution (Marquis & Voss 1981). As Marquis and Voss (1981) point out, these explanations are most plausible for northern taxa, or strictly cordilleran species, particularly those characteristic of disturbed or open habitats and producing numerous, broadly dispersed seeds. *D. hookeri* appears to fit these theories poorly, with its few, presumably vertebrate-dispersed fruits, and most importantly its clear affinity for mature, mesic forest both within its major range in the Pacific Northwest and in the sites in which it has been found in our region.

Recently, Solheim and Judziewicz (1984), in reporting the discovery of *Polemonium occidentale* Greene in a northern Wisconsin commercial forest raised the possibility of dispersal on the boots of foresters who are typically airlifted to fight western fires and then return to the midwest. With *D. hookeri*, and its occurrence in a wilderness preserve, the boots of traveling

Figure 2. Photograph of *Disporum hookeri* var. *oreganum* taken on 3 July, 1988. Immature fruits are creamy-white.

campers or hikers may be more plausible. However, it also may not be the case that the dispersal of this taxon has occurred recently. The widespread locations of my collections and that of Thompson (*M-1593*, 30 May 1968, BLH) within Porcupine Mountains Park may indicate a species that has been present for some time, but is not an effective competitor in its new habitat. A possible explanation may be the climate within its primary range

and particularly growing season length. Throughout its western range, which is entirely under maritime influence, extreme winter temperatures are much more moderate than those of the Lake Superior region (Franklin & Dyrness 1973, National Oceanic and Atmospheric Administration 1974). In addition, growing seasons are typically much longer, and in the case of lowland areas west of the Cascades up to twice as long (Franklin & Dyrness 1973, National Oceanic and Atmospheric Administration 1974). It may be that individuals are able to survive in our region as below-ground perennials, protected by the deep snows of the Lake Superior snow belt, but that years in which fruits mature are very rare, thus resulting in a slowly spreading, but sparse population.

CONCLUSIONS

Due to its mature, mesic forest habitat, explanations of the arrival and distribution of *Disporum hookeri* var. *oreganum* in Michigan are likely to remain problematic. Of all the western disjuncts, the nature of its habitat and dispersal make the presence of *D. hookeri* in the Lake Superior region among the most difficult to explain. Likewise, it appears that its rarity in this region may in fact be real, given the generally high level of plant investigations that historically have occurred in the Porcupine Mountains, without revealing this species sooner or at higher population levels. Continued field searches for this taxon will help in evaluating these ideas, and discovery of additional populations may allow a better understanding of its habitat requirements and behavior in this region.

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PUBLICATIONS OF INTEREST

THE GARDEN PRIMER. Barbara Damrosch. Workman Publishing, Inc., 708 Broadway, New York, 10003. 1988. viii + 673 pp. $14.95. The book discusses annuals, perennials, vegetables, fruits, shrubs and trees, lawns and ground covers, and, last but not least, houseplants. Various gardening styles are acknowledged but are not discussed in any depth. Insect pests and plant diseases are briefly mentioned but no illustrations are provided to help the gardener in identification. Suggestions for pest and disease control consist of good gardening practices ("good housekeeping").

While there is much practical information in the book, I am reluctant to endorse it totally. I find myself wishing the author had covered fewer topics in greater depth. The book also could be much better illustrated. This is another book to borrow from the library before you decide to buy.

THE IMPATIENT GARDENER. Jerry Baker. Ballantine books, 201 E. 50th St., New York, 10022. 228pp. 1983. $6.95. This book is available at several discount stores and quite possibly at the local library. Baker discusses, in a folksy manner, his method of maintaining gardens, lawns, perennials, and shrubs and trees. The book is profusely illustrated with line drawings and has much information conveniently placed in several charts. I really appreciate illustrations and charts; if they are good, they save me time.

Some of his gardening advice will be found in the Cooperative Extension literature in a less entertaining format. Some of his advice, however, is not standard and should be viewed with some caution. Generally, his homemade pest sprays and fertilizers are more expensive then the commercial varieties, some of the ingredients are of questionable value, and in some cases can chemically burn the plants sprayed.

My recommendation is to borrow the book first and if you like it, then buy it.

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CLIFF BRAKE ON DRUMMOND ISLAND: A GRAVEL ROADSIDE LOCALITY FOUND BY AMATEUR BOTANISTS

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Ann Arbor, MI 48105

The potential discovery of a plant which is unique (by its rarity or its adaptation) is often a goal of both professional and amateur botanists. Although an experienced observer would seem to have a distinct advantage in the discovery of "rarities," the contributions of alert amateurs can be considerable.

In October, 1988, I took an adult education class from the Matthaei Botanical Gardens to Drummond Island, Michigan for four days of botany and canoeing/kayaking. During the Ann Arbor orientation, I had given the students information on some of the unusual plants found on the island, including those in the alvar community (limestone slabs and outcrops), such as *Pellaea glabella* Mett. ex Kuhn, the smooth cliff brake, which had been found only twice on the island. State Geologist Douglass Houghton had left only scanty field notes in his original collection on August 3, 1839, so the fern had been difficult to relocate. Jarl Hiltunen (1962), in *Notes on the Flora of Chippewa County, Michigan*, related his difficulties both in interpreting the notes and in actually reaching the locality. The fern was known from only this one station, on a remote promontory known as "Marblehead," located on the eastern curve of the island. Hiltunen subsequently found it there again.

Upon reaching Drummond Island on our weekend trip (Oct. 28–30, 1988), the adult education students were eager to continue the game of botanical hide-and-seek, in spite of temperatures hovering at 32°F. Among those students involved with the plant expedition were Rochelle Drouare, Len Gajda, Roxie and Ervin Holland-Moritz, and Jon La Bossiere. By using the Chippewa Co. Plat Book to find a legal put-in point for our boats on state land, I chose Huron Bay, on the south side of Drummond Island. Before setting out in the boats, I discussed the plants found around us, sprawling over the rocks. These plants were mostly bearberry, *Arctostaphylos uva-ursi* (L.) Sprengel, and horizontal juniper, *Juniperus horizontalis* Moench; sparse woody plants gave a slight wind break comprised of balsam fir, *Abies balsamea* (L.) Miller, common juniper, *Juniperus communis* L., white spruce, *Picea glauca* (Moench) A. Voss, and white cedar, *Thuja occidentalis* L..

Just as we were preparing to launch our kayaks, about 15 miles from the Marblehead locality, an excited Rochelle found a plant strongly resembling

the cliff brake. The unlikely locality was four feet from the road, snuggled against a 4″ ledge on a slab of limestone, partially covered with road gravel and a dead *Juniperus communis*. The boat paddle in the breezy coolness was obviously anticlimactical.

The fern was not the same species we had discussed but an even rarer one: purple cliff brake, *Pellaea atropurpurea* (L.) Link, with only a handful of Michigan localities in Keweenaw Co. on the east and west bluffs of the Brookway Mountain area on "wind-swept crests, crevices, and talus of sandstone conglomerate" (*Fernald & Pease 3025*, MICH). From specimens deposited at the University of Michigan herbarium (MICH), the closest locality of *P. atropurpurea* to Drummond Island is Manitoulin Island, a Canadian island whose nearest tip is 25 miles east and which is located on the same limestone escarpment which formed Drummond Island. Another Canadian locality is on Isle St. Ignace (St. Ignace Island) which lies north across Lake Superior from the Keweenaw County locality. Every specimen at MICH (other than the sandstone conglomerate of the Keweenaw County locality) which had substrate information listed was located on some form of limestone or dolomite substrate. Other than scattered stations in Minnesota, Ohio, and southern New England, *P. atropurpurea* had been found mostly in the southern and southwestern states, ranging from Virginia to Arkansas to Texas. Knowing no border restrictions, *Pellaea atropurpurea* is also found in such localities as Nuevo Leon, Guatemala (in "crevices of the walls of the pyramid of Zaculen . . . plastered with lime" (*Skutch 1596*, MICH) and in the northern Sonoran area of Mexico.

Anton Reznicek and Warren H. Wagner both verified the species based on dried material. *Pellaea atropurpurea* is listed as "threatened" on the Michigan Endangered Species List of the Department of Natural Resources (1987).

I revisited the locality on September 22, 1989 and again on November 12, 1989. I was pleased to find the fern doing well, still in the gravel alongside the road, with 18 fronds now, instead of the 14 found last year. The locality is 1.25 miles from the intersection of Drummond Road with the Warner Bay Road in Section 14, T41N, R5E. The cliff brake is located on the Potagannissing-Rock Outcrop complex of exposed limestone bedrock. This type is known for slow surface run-off and sporadic 8′–10′ areas of ponded water. The fern clump, which is visible from the road, is 197 feet from the Huron Bay high water mark and an additional 91 feet from the water, placing the fern 288 feet from open water. Due to the distance from the water and the drought conditions in the past few years (Stephenson & Herendeen 1986), it seemed good indeed to find it still healthy. The locality appears to be just barely inside state land, which has probably kept it from becoming a cabin's front yard, as is the case with an area a few hundred feet to the south.

Hopefully this report will encourage amateurs to take confidence in what they know, to question what is not known, and to report unusual finds to the botanical community.

LITERATURE CITED

Hiltunen, J. K. 1962. Notes on the Flora of Chippewa County, Michigan. Michigan Bot. 1:23–26.

Michigan Department of Natural Resources. 1987. Michigan Endangered, Threatened and Special Concern Plant and Animal Species 3rd revision. Wildlife Division, Lansing, MI. 23 pp.

Stephenson, S. N., & P. S. Herendeen. 1986. Short-term drought effects on the alvar communities of Drummond Island, Michigan. Michigan Bot. 24:16–27.

√ **REVIEW**

COLLECTING, PROCESSING, AND GERMINATING SEEDS OF WILDLAND PLANTS. By James A. Young and Cheryl G. Young. Timber Press, 9999 S.W. Wilshire, Portland, OR. 97225. 1986. vi + 236 pp. $24.95.

Recent interest in the use of native plants in garden design or in habitat restoration has spawned a wealth of articles and books on growing and establishing native species. Many of these books concentrate on a single plant community such as the prairie or else are organized to be more regional in focus. The authors of *Collecting, Processing, and Germinating Seeds of Wildland Plants* have attempted to compile scattered information on the seeds of wild plants into one book applicable to all of North America. It is directed towards amateur gardeners, professional seed producers, wildland managers, and generally anyone with an interest in propagating wild plants. The book is organized with an introductory section describing the general biology of seeds, a sequence of chapters outlining methods for seed collection, threshing, cleaning, storage, and germination, and chapters on the seeds of trees, shrubs, and herbaceous species with information grouped by genus (trees and shrubs) and family (herbaceous plants). The authors have also included a glossary of botanical terms and a tabular listing of the species discussed in the text. A unique feature of the book is the inclusion of the seeds and germination of weedy exotic species which as the authors point out is useful in designing a management program for their control.

As a compilation of the current literature on seed germination of native plants and naturalized exotics, the book is extremely useful. Much of the work that is cited in the text on individual species is widely scattered in journals and government reports that would be difficult for the average person to track down. The information given for a particular genus or family varies considerably and the authors often point to the need for additional research. In many cases, however, the original sources provide greater detail and depth than offered here in the short summaries. One such source is *Agriculture Handbook No. 450: Seeds of Woody Plants in the United States* (C. S. Schopmeyer, technical coordinator. 1974. Washington, DC: Forest Service, U.S. Department of Agriculture) which is frequently referred to in the text. *Agriculture Handbook No. 450* provides a much

greater wealth of information about each species and germination procedures as well as photographs or drawings of the seed pods, seeds, and seedling plants. Regional guides such as *Prairie Propagation Handbook* (Harold W. Rock. 1977. Milwaukee, WI: Wehr Nature Center, Whitnall Park) provide simple but in many ways more complete suggestions based on the ecology of a given plant community. With its broad geographic focus, *Collecting, Processing, and Germinating Seeds of Wildland Plants* is able to provide a general coverage, but consulting these other sources is necessary when more detail is desired.

The sections on seed collection, post harvest handling, cleaning, and germination provide a good overview of general processes and equipment. Greater use of diagrams and illustrations to explain the equipment and procedures described would make these chapters easier to read and to understand. The authors have included several helpful suggestions for making homemade devices for collecting and cleaning seeds, but more attention could have been given to vast amount of homespun wisdom and ingenious practices that abound in circles of people actively propagating native plants.

Notably lacking in the entire book is any discussion of the need for permission or permits in the collecting of seeds in the wild or a set of guidelines for ethical collection procedures. The authors provide no guidelines for numbers of seeds (or plants) that can be collected from a given population or even express this as a concern. For a book towards the general public, this omission is inexcusable. The successful propagation of native species is a admirable goal in itself, but such efforts must be combined with a conscious commitment to insure that native stands are preserved.

—Robert E. Grese
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V

MICHIGAN PLANTS IN PRINT
New Literature Relating to Michigan Botany

Continued from this journal 28:40 (1989). For description of this series, see 26:174 (1987).
—Edward G. Voss

A. MAPS, SOILS, GEOLOGY, CLIMATE, GENERAL

Baumgartner, David C., & Robert J. Marty. 1988. Evaluation of Resources at Risk from Wildland Fires. U.S.D.A. Forest Serv. Gen. Techn. Rep. NC-124. 12 pp. [Analysis done in northern Lower Peninsula; includes map showing sites of Michigan's 12 largest fires 1964–1985, with indication of acreage and cover.]

Great Lakes Commission. 1986. Water Level Changes Factors Influencing the Great Lakes. 13 pp. $1.25. [A survey of all the factors involved, including precipitation, runoff, evaporation, crustal uplift, flooding, diversions, control structures, plus potential modifications, with tables and figures.]

Ohmann, Lewis F., David F. Grigal, & Sandra Brovold. 1989. Physical Characteristics of Study Plots Across a Lake States Acidic Deposition Gradient. U.S.D.A. Forest Serv. Resource Bull. NC-110. 47 pp. [Tables present geological and soils data for plots from northern Lower Michigan to Minnesota, with many of them in jack pine, red pine, balsam fir, sugar maple, and aspen types in Michigan.]

Rennicke, Jeff. 1989. Isle Royale: Moods, Magic, & Mystique. Isle Royale Natural History Association, Houghton. 40 pp. $7.95 + $1.50 p/h. [A beautiful picture book showing in full color some of the plants and vegetation as well as other scenery. (Persons interested in Isle Royale may also note that the May/June 1990 number of *Michigan History* is a special Isle Royale issue.)]

(U.S. Department of Agriculture, Soil Conservation Service). Soil surveys for Baraga, Dickinson, and Menominee counties have been distributed since our previous listings in October 1987. These all include complete aerial photographic coverage with boundaries of soil types overprinted. Such surveys are very useful in planning or interpreting field work. Michigan surveys are available from Soil Conservation Service. USDA, 1405 S. Harrison Rd., Room 101, East Lansing, MI 48823.]

(U.S. Geological Survey). Since the previous mention of topographic maps in this column (October 1987), 104 new 7½-minute quadrangle maps have been issued for Michigan (through December 1989). Of these, 85 are "provisional" and the most recent 19 are "standard" (the latter all for the western U.P.). Space does not permit listing all of them here. In addition, a new 1:62,500 map for Isle Royale, folded and on water-resistant paper, is available for $5.00. Regular maps are $2.50. New "intermediate-scale" maps (1:100,000), at $4.00 each, have been published in 1990 for 30 × 60 minute areas named Beaver Island, Cedar Springs, Cheboygan, and Twohearted River. A new and improved booklet-format index to coverage and a catalog of published maps as of July 1988 are available without charge from the same address as that for placing orders: Map Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225.]

B. BOOKS, BULLETINS, SEPARATE PUBLICATIONS

Blyth, James E., Anthony K. Weatherspoon, & W. Brad Smith. 1988. Michigan Timber Industry—An Assessment of Timber Product Output and Use. U.S.D.A. Forest Serv. Resource Bull. NC-109. 54 pp. [Supersedes a 1977 report and gives extensive data, mostly by county and species group, for saw log, pulpwood, veneer log, and other categories; includes map showing number and type of wood-using mills in the state in 1984.]

Brand, Gary J. 1985. Environmental Indices for Common Michigan Trees and Shrubs. U.S.D.A. Forest Serv. Res. Pap. NC-261. 5 pp. [Lists 90 trees and shrubs with environmental indices (moisture, nutrients, heat, and light) compared for Minnesota and Michigan. Some listings are only by genus, and "Salix spp." for a genus of species ranging from very wet to very dry in habitat is not really helpful.]

Case, Frederick W., Jr. 1987. Orchids of the Western Great Lakes Region. Rev. Ed. Bull. Cranbrook Inst. Sci. 48. 251 pp. $28.95. [See review in this journal 27:93 (1988).]

Ireland, Robert R. 1969. A Taxonomic Revision of the Genus Plagiothecium for North America, North of Mexico. Natl. Mus. Canada Publ. Bot. 1. 118 pp. [Dot distribution maps show Michigan occurrence of 11 species in this and three closely related genera of mosses; selected specimen citations usually are fewer.]

Isely, Duane. 1981. Leguminosae of the United States. III. Subfamily Papilionoidae: Tribes Sophoreae, Podalyrieae, Loteae. Mem. New York Bot. Gard. 25(3). 264 pp. $35.00 [*Baptisia lactea* mapped from 1 of the 13 known Michigan counties for it, *B. leucophaea* (as *B. bracteata*) not from the state at all, *B. tinctoria* from 1 of the 12 known counties, and the introduced *Lotus corniculatus* only as a state record. Keys and full descriptions provided.]

Landolt, Elias. 1986. The Family of Lemnaceae—A Monographic Study Vol. 1. (Biosystematic Investigations in the Family of Duckweeds (Lemnaceae) Vol. 2). Veröff. Geobot. Inst. ETH Stiftung Rübel Zürich 71. 566 pp. [Morphology, ecology, and distributions of the duckweeds, with maps, color and black & white photos, SEM photos, drawings, and descriptions—but no keys. *Lemna minor*, *L. turionifera*, *L. trisulca*, *Wolffia borealis* (= *W. punctata* auctt.), and *W. columbiana* mapped from Michigan and said to be "frequent" here; *L. valdiviana* mapped and said to be "rare"; *W. brasiliensis* (= *W. papulifera*) mapped and said to be "rather rare."]

Rogers, C. M. 1984. Linaceae. North Amer. Fl. II(12). 58 pp. $10.75. [Only *L. catharticum* and *L. virginianum* are specifically mentioned as occurring in Michigan.]

Rouse, Cary. 1989. Fire Effect in Northeastern Forests: Red Pine. U.S.D.A. Forest Serv. Gen. Techn. Rep. NC-291. 9 pp. [Overview of subject; includes brief references to the Mack Lake fire in Michigan.]

Smith, W. Brad, & Jerold T. Hahn. 1986. Michigan's Forest Statistics, 1987: An Inventory Update. U.S.D.A. Forest Serv. Gen. Techn. Rep. NC-112. 44 pp. [In this report, submitted and approved for publication in 1986, the authors declare how timberland area in Michigan "declined" to 17.3 million acres in 1987, tree biomass "totaled" 1.2 billion green tons in 1987, and what other events happened in a year not yet begun. "Principal Tree Species Groups in Michigan" include *Carya tomentosa*, *Betula lenta*, *B. nigra*, *Quercus prinus*, and others that are non-existent or extremely rare in the state. The river birch group, e.g., is predicted to have 0.8 million board feet of sawtimber in Michigan in 1987. The statistics for species that *do* grow in the state may be of more interest.]

Stuckey, Ronald L., & Karen J. Reese (eds.). 1981. The Prairie Peninsula—In the "Shadow" of Transeau: Proceedings of the Sixth North American Prairie Conference. The Ohio State University, Columbus, Ohio 12–17 August 1978. Ohio Biol. Surv. Biol. Notes 15. 278 pp. $12.50. [For included Michigan-related papers, see titles under D below by Stuckey and under C by Chapman, Fleckenstein, Kohring, and Thompson.]

C. JOURNAL ARTICLES

Al-Shehbaz, Ihsan A., & Vernon Baker. 1987. Armoracia lacustris (Brassicaceae), the correct name for the North American lake cress. J. Arnold Arbor. 68: 357–359. [*A. aquatica* is an illegitimate homonym and cannot be used; distribution map includes Michigan counties for this "threatened" species.]

Bearss, Rachel E., & Ronald O. Kapp. 1987. Vegetation associated with the Heisler mastodon site Calhoun County, Michigan. Michigan Academ. 19: 133–410. [Includes pollen profile for the site, where mastodon bones came from horizon of conifer wood, apparently spruce.]

Boufford, David E. 1983 ["1982"]. The systematics and evolution of Circaea (Onagraceae). Ann. Missouri Bot. Gard. 69: 804–994. [A world monograph, with distribution of both Michigan species thoroughly documented by citation of specimens and dots on maps; the hybrid, *C.* ×*intermedia*, documented only from Marquette Co.]

Buddell, George F., II, & John W. Thieret. 1985. Notes on Erigenia bulbosa (Apiaceae). Bartonia 51: 69–76. [Distribution map shows the species in 13 Michigan counties.]

Cantino, Philip D. 1982. A monograph of the genus Physostegia (Labiatae). Contr. Gray Herb. 211: 1–105. [Recognizes only *P. virginiana* ssp. *virginiana* as native in Michigan, with

more dots on distribution map than the single representative specimen cited (from Houghton Co.); a few specimens from within the native range are mapped as escapes from cultivation.]

Chapman, Kim Alan, & Robert J. Pleznac. 1981. A survey of prairie preservation and reconstruction in Michigan. Ohio Biol. Surv. Biol. Notes 15: 151–155 (= Proc. North Amer. Prairie Conf. 6). [Brief descriptions of 24 preserved projects plus several unprotected and recommended sites.]

Crins, William J., & Peter W. Ball. 1989. Taxonomy of the Carex flava complex (Cyperaceae) in North America and northern Eurasia. II. Taxonomic treatment. Canad. J. Bot. 67: 1048–1065. [Key, photos of perigynia, distribution maps showing in Michigan *C. flava*, *C. cryptolepis*, and *C. viridula* var. *viridula*.]

Fleckenstein, Michael. 1981. Comparisons between a prairie grove in Illinois and southwestern Michigan. Ohio Biol. Surv. Biol. Notes 15: 155–156 (= Proc. North Amer. Prairie Conf. 6). [Very brief remarks include the "Island" at Schoolcraft, Kalamazoo Co.]

Harms, Vernon L. 1985. A reconsideration of the nomenclature and taxonomy of the Festuca altaica complex (Poaceae) in North America. Madroño 32: 1–10. 1985. [*F. altaica* spp. *scabrella* mapped in northern Lower Peninsula and its Michigan occurrence mentioned (erroneously as spp. *major*) in the text.]

Holman, J. Alan, Daniel C. Fisher, & Ronald O. Kapp. 1986. Recent discoveries of fossil vertebrates in the Lower Peninsula of Michigan. Michigan Academ. 18:431–463. [An overview, based on numerous sites, including discussion of late Pleistocene vegetation and climate, with tables of pollen associated with mastodont, mammoth, musk ox, and elk fossils.]

Hough, R. Anton. 1979. Photosynthesis, respiration, and organic carbon release in Elodea canadensis Michx. Aquatic Bot. 7: 1–11. [Work done at Shoe Lake, Oakland, Co.]

Johnson, George P. 1988. Revision of Castanea sect. Balanocastanon (Fagaceae). J. Arnold Arbor. 69: 25–49. [Includes a county distribution map of *C. dentata*—which is not in this section—but does not indicate in which counties the collections were made from planted trees, so the indicated occurrence north to Emmet Co. is very misleading.]

Kapp, Ronald O. 1986. Late-glacial pollen and macrofossils associated with the Rappuhn mastodont (Lapeer County, Michigan). Amer. Midl. Naturalist 116: 368–377.

Kohring, Margaret A. 1981. Saving Michigan's railroad strip prairies. Ohio Biol. Surv. Biol. Notes 15: 150–151 (= Proc. North Amer. Prairie Conf. 6). [Briefly describes 6 areas in Berrien, Cass, and Van Buren counties and the management agreement with AMTRAK.]

Loveless, M. D., & J. L. Hamrick. 1988. Genetic organization and evolutionary history in two North American species of Cirsium. Evolution 42: 254–265. [Suggests that *C. pitcheri* is derived from *C. canescens* of the Great Plains, migrating into the Great Lakes region in postglacial time; indicates several study sites in Michigan.]

Naczi, Robert F. C. 1990. The taxonomy of Carex bromoides (Cyperaceae). Contr. Univ. Mich. Herb. 17: 215–222. [Distribution map has dots for ssp. *bromoides* in southern Lower Peninsula and western Upper Peninsula.]

Peng, Ching-I. 1988. The biosystematics of Ludwigia sect. Microcarpium (Onagraceae). Ann. Missouri Bot. Gard. 75: 970–1009. [No key; distribution map for *L. polycarpa* shows 10 locations in Michigan and chromosome number of n = 16 from Washtenaw Co. material; map fails to show any Michigan locality for *L. sphaerocarpa*.]

Peng, Ching-I. 1989. The systematics and evolution of Ludwigia sect. Microcarpium (Onagraceae). Ann. Missouri Bot. Gard. 76: 221–302. [Cites *L. polycarpa* from 10 Michigan counties and maps it from 9 (omitting Houghton, but including Genesee, to which a Farwell collection from Linden Park (Detroit) is erroneously attributed). Range of *L. sphaerocarpa* does not include Michigan, where it was first collected in 1981.]

Roberts, Marvin L. 1985. The cytology, biology and systematics of Megalodonta beckii. Aquatic Bot. 21: 99–110. [Includes observations on pollination in Missaukee Co.]

Schloesser, Donald W., Charles L. Brown, & Bruce A. Manny. 1988. Use of aerial photography to inventory aquatic vegetation. J. Aerospace Engin. 1: 142–150. [Low-altitude aerial photography used to assess aquatic macrophytes in St. Clair and Detroit rivers.]

Shaffer, Robert L. 1990. Notes on the Archaeinae and other Russulas. Contr. Univ. Mich.

Herb. 17: 295–306. [*R. lutea* cited from localities in 6 northern Michigan counties, *R. xantho* sp. nov. (type loc., Emmet Co.) also cited from Cheboygan Co.]

Shoshani, Jeheskel. 1989. A report on the Shelton mastodon site and a discussion of the numbers of mastodons and mammoths in Michigan. Michigan Academ. 21: 115–132. [Includes comments on vegetation and radiocarbon date indicating Twocreekan time in Oakland Co.]

Smith, P. G., & J. B. Phipps. 1987. Studies in Crataegus (Rosaceae, Maloideae). XVI. Taxonomy of C. series Rotundifoliae in Ontario. Canad. J. Bot. 65: 2646–2667. [Includes designations of Michigan neotypes from merotypes of *C. dodgei* and *C. lumaria*.]

Tans, William E., & Hugh H. Iltis. 1980 ["1979"]. Preliminary reports on the flora of Wisconsin No. 67. Verbenaceae—Vervain Family. Trans. Wisconsin Acad. Sci. 103: 78–94. [Distribution map of *V. urticifolia* includes dots in Michigan.]

Thompson, Paul W. 1981. Flora of Dayton Prairie, a remnant of Terre Coupee Prairie, in Michigan. Ohio Biol. Surv. Biol. Notes 15: 148–150 (= Proc. North Amer. Prairie Conf. 6). [Chiefly a list of species.]

Trynoski, Stephen E., & Janice M. Glime. 1982. Direction and height of bryophytes on four species of northern trees. Bryologist 85: 281–300. [Analysis of epiphytes on deciduous trees in Keweenaw Co.]

Vitt, Dale H. 1976. The genus Seligeria in North America. Lindbergia 3: 241–275. [Four species in this genus of tiny mosses occur in Michigan, as documented by cited specimens and shown on distribution maps.]

Vitt, Dale H., & Peter Lee. 1985. Anomodon minor (Musci: Leskeaceae) in North America. Bryologist 87: 338–339. [Distribution map includes dots throughout Michigan.]

Wagner, W. H., Jr., & Florence S. Wagner. 1983. Genus communities as a systematic tool in the study of New World Botrychium (Ophioglossaceae). Taxon 32: 51–63. [Much of the discussion and most of the photographs derived from Michigan material.]

Wagner, W. H., Jr., & F. S. Wagner. 1990. Moonworts (Botrychium subg. Botrychium) of the upper Great Lakes region, U.S.A. and Canada, with descriptions of two new species. Contr. Univ. Mich. Herb. 17: 313–325. [Five species, of which *B. campestre* is cited and mapped from Michigan localities, *B. hesperium* cited, and *B. acuminatum* described as new (type locality, Alger Co.]

Waldron, Gerald E., Steven W. Aboud, John D. Ambrose, & George A. Meyers. 1987. Shumard oak, Quercus shumardii, in Canada. Canad. Field-Naturalist 101: 532–539. [Cities recent collections by senior author from Monroe Co., Michigan, and dismisses pre-1985 reports from Michigan as unconvincing; fuller details given for recent Ontario collections.]

Wells, J. R., P. B. Kaufman, J. D. Jones, G. F. Estabrook, & N. S. Ghosheh. 1982. Contents of some heavy metals in plants from Saginaw Bay (Lake Huron) and some small lakes in wilderness areas of Michigan's Upper Peninsula as analyzed by neutron activation analysis. J. Radioanalyt. Chem. 71: 97–113. [Aquatic plants sampled from Huron Mountains and several sites around Saginaw Bay; some species were better than others at accumulating ions of heavy metals. (First 3 lines of this entry inexplicably lost after proofreading previous listing, 27: 30 (Jan. 1988).)]

Whitney, Gordon G. 1986. Relation of Michigan's presettlement pine forests to substrate and disturbance history. Ecology 67: 1548–1559. [Original vegetation of Crawford and Roscommon cos., as interpreted from General Land Office records, and subsequent history as related to soils, windfall, and fires—with small maps.]

Whitney, Gordon G. 1987. An ecological history of the Great Lakes forest of Michigan. J. Ecol. 75: 667–684. [Study in Crawford and Roscommon cos., including small maps showing areal change in forest types at intervals 1857–1978, based on presettlement survey records, fire history, contemporary forest surveys, and other data.]

Winters, Harold A., Richard L. Rieck, & Ronald O. Kapp. 1986. Significance and ages of mid-Wisconsinan organic deposits in southern Michigan. Phys. Geogr. 7: 292–305. [Includes data on pollen and other microfossils from a well site in Kalkaska Co., indicating a much cooler climate than at present ca. 35,000 B.P. with a predominantly coniferous forest.]

Winn, Gerald D., & Ronald O. Kapp. 1987. An ecological survey of the Ore-Ida Prairie Preserve, Newaygo county, Michigan. Michigan Academ. 19: 209–216. [Includes lists—with over a dozen spelling errors—for species on different soils.]

D. HISTORY, BIOGRAPHY, EXPLORATION

Barillas, William. 1989. Michigan's pioneers and the destruction of the hardwood forest. Michigan Hist. Rev. 15(2): 1–22. [Contrasts the pitiful destruction in southern Michigan of the state's hardwood forests (primarily to obtain agricultural land) with similar destruction (for timber) of areas farther north, both without appreciation of longer-term values.]

Brodie, Harold J. 1987. Constantine John Alexopoulos, 1907–1986. Mycologia 79: 163–165. [Sketch of distinguished mycologist whose career included the years 1947–1956 at Michigan State University.]

Cook, William. 1987. The *Wen*, the *Botany*, and the *Mexican Hat*. Callisto Books, Orangevale, California. 151 pp. $8.75. [See review in this journal 29: 74 (1990), regarding exploits of Elzada U. Clover.]

(Gleason, H. A.) 1987. A letter from Dr. Gleason. Brittonia 39: 205–209. [A mostly autobiographical letter, written in 1952, including comments on pioneer ecological work in Michigan by Beal and Whitford.]

Steere, William Campbell. 1977. North American muscology and muscologists a brief history. Bot. Rev. 43: 285–343. [Includes section on George E. Nichols, who taught at University of Michigan Biological Station (and collected) 1920–1937.]

Stuckey, Ronald L. 1981. Origin and development of the concept of the Prairie Peninsula. Ohio Biol. Surv. Biol. Notes 15: 4–23 (= Proc. North Amer. Prairie Conf. 6). [Includes maps and notes on the contributions of Michigan-related E. N. Transeau (at Univ. Mich. 1902–1904, Alma Coll. 1904–1906) and H. A. Gleason (at Univ. Mich. 1910–1919).]

Stuckey, Ronald L. 1981. Contributors to the development of the Prairie Peninsula concept. Ohio Biol. Surv. Biol. Notes 15: 24–36 (= Proc. North Amer. Prairie Conf. 6). [Portraits and very brief notes on Asa Gray, H. C. Cowles, C. C. Adams, E. N. Transeau, H. A. Gleason, and 7 others.]

Thiers, Harry D. 1987. Alexander H. Smith, 1904–1986. Mycologia 79: 811–818. [Includes list of publications of this prolific author and collector, associated with University of Michigan since 1928; see also this journal 27: 21–25 (Jan. 1988).]

Wynne, M. J. 1985. A tribute to professor Wm. Randolph Taylor. Phycologia 24: 259–261. [Brief sketch, with photo, of the University of Michigan's professor emeritus and curator emeritus of algae, who observed his 90th birthday Dec. 21, 1985.]

ANNOUNCEMENT

The Ohio State University Herbarium
1735 Neil Avenue, Columbus, Ohio 43210

1990-1991 PUBLIC LECTURE SERIES
"Plant Conservation—Ohio and Around the World"

November 6 **Merging Recreation and Preservation: Ohio's State Park System.** Ronald Mills, Naturalist, Division of Parks and Recreation, Ohio Department of Natural Resources.

December 4 **Conserving Ohio's Natural Heritage: Ohio's Nature Preserves Program.** Richard Moseley, Chief, Division of Natural Areas and Preserves, Ohio Department of Natural Resources.

January 8 **The Nature Conservancy: Preserving Ohio's Diversity.** Jeffrey Knoop, Director, Ohio Lands Protection Program, Ohio Field Office, The Nature Conservancy.

Each presentation will begin at 8:00 P.M. in Room 208, Botany and Zoology Building, with refreshments served afterwards in the Herbarium, Rm. 312. Parking is available in the 12th Avenue Garage, located just west of the B & Z Building. For further information, call Dr. John Furlow at 614-292-3296.

CONTENTS

On the cover: *Chicory (*Cichorium intybus*) and visitor, at the University of Michigan Biological Station, Douglas Lake, Michigan.*
Photographed by Manny Payne, 26 August 1987.

Vol. 29, No. 4

THE MICHIGAN BOTANIST

October, 1990

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RIVER BIRCH IN CENTRAL WISCONSIN: A CASE STUDY OF COLONIZATION

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River birch (*Betula nigra* L.), also called red birch, is a species of minor importance in Wisconsin, of interest chiefly for its limited range and habitat. It is endemic to stream banks and floodplains of the southern coastal plain. Early reports indicated river birch extended up the flood plain of the Mississippi River to 70 miles below Minneapolis and up the Wisconsin River to Stevens Point in central Wisconsin (Fassett 1930). In these two valleys it overlaps geographical range with its boreal relative (*Betula papyrifera* Marshall), white or paper birch, by roughly 100 miles. Where they overlap, my observations indicate they do not coexist; red birch occupies the floodplains and paper birch the drier uplands, though the latter occupies floodplain and swamp edges where river birch is absent.

Neither *Spring Flora of Wisconsin* (Fassett 1976) nor J. T. Curtis's classic *Vegetation of Wisconsin* (1959) report river birch as occurring in the state outside of those two drainages. While canoeing the upper Fox River I noted red birch along the banks and, with reflection on the history of that river, decided they probably arrived there as a result of the construction of the Fox-Wisconsin Canal at Portage, Wisconsin late in the last century. I began this study to document the pattern and extent of colonization of the upper Fox by river birch.

Headwaters of the upper Fox are 20 miles east of Portage. Leaving Portage, the Fox meanders north and east through marshes, shallow impoundments, and low woodlands, eventually flowing into Lake Michigan at Green Bay. Over most of its 150 mile length the Fox is shallow, slow, and of low (10.16cm/per mile) gradient (Gard & Reetz 1973). At the historic portage site between the Fox-Great Lakes-St. Lawrence drainage and the Wisconsin-Mississippi drainage to the Gulf of Mexico, the two rivers are less than two miles apart, differ by several feet in elevation, and are separated by low marshy ground.

Demand for military and commercial transport between the Great Lakes and the Mississippi River during the early 1800s inspired several attempts (1838, 1849–51) to build a canal at Portage (Curtis 1974). The Army Corps of Engineers built locks and dams for a successful canal in 1874–76. Eventually railroad competition for cargo hauling reduced barge traffic. The canal required redredging every 25 years to maintain a 21.3 × 1.22 meter channel, an expense deemed excessive as barge traffic declined. The canal was declared closed in 1951, 25 years after its last dredging (Curtis 1974).

METHODS

Between July 15 and August 15, 1989, I canoed and surveyed large sections (roughly 30 miles total) of the Fox River between Portage and the White River below Princeton looking for river birch. Where the species was present, I measured circumference 1.2 meters above the ground of all trees in randomly chosen isolated stands (sites 4–6, farthest downriver) or attempted to get a representative sample of sizes by measuring all individuals within 92.3 × 92.3 meter areas centrally located within large continuous stands (sites 1–3) (Fig. 1). Only the single largest trunk was measured for multiple-trunked trees at sites 2–6. Cores were collected with an increment borer for each size class of tree heavily represented in the sample and rings counted with a dissecting microscope to determine ages and approximate growth rates to help establish the time of colonization by the species. Frequency of each size of tree was tallied by two inch increments and plotted for all six sites. A Kolmogorov-Smirnov test (Zar 1974) was used to compare size class frequencies to determine whether a significant difference existed between sites. An a posterori Chi square, using 20.3 cm circumference increments, was used to determine whether size distribution was random or nonrandom for the sample.

RESULTS

The initial survey indicated that river birch was present only in the first twenty river miles downstream from Portage, limited to Columbia and Marquette counties. Of an estimated population of 500–1000 trees present in that distance, data collection included measurement of 244 specimens. Distribution of the species was uneven with the largest trees and greatest concentrations near the Portage canal (site 1) and isolated stands with fewer size classes represented and of lesser age and size farther downstream (Fig. 2). Surprisingly, there were few river birch in the first eight miles below Portage. This area is an extensive low marsh which I believe was swept regularly by grass fires until the last 30 years when much of it was drained and converted to agriculture. The four groups of river birch observed in this first stretch included two separated by only 300 meters which included 75–100 year old trees with younger ones near them. Below Governor Dodge Island Park were two widely separated small trees, 40–50 cm circumference, both in areas of recent human disturbance. Below this area, river birch were much more frequent as isolated stands located on old canal dredge banks, clustered around one or several large (120–160 cm circumference) trees. Large trees in these stands were surrounded by 4–20 medium-size trees (75–100 cm circumference) and then many smaller trees, increasing in number as size decreased. The site farthest downstream from the canal (site 6) was the only one lacking river birch over 82 cm circumference. A Kolmogorov-Smirnov test comparing frequency distribution of size classes from the six sites indicated a significant difference ($P = 0.05$, 0.64) only between the first and last sites.

Increment cores indicated the following approximate age/size relationships for all populations where each was found: 180 cm circumference, 65 years old; 107 cm circumference, 43 years; 64 cm circumference, 26 years; 30 cm, eleven years. Data indicate a fairly rapid growth rate and a uniform annual increase in circumference of roughly 2.54 cm per year for trees up to 65 years old.

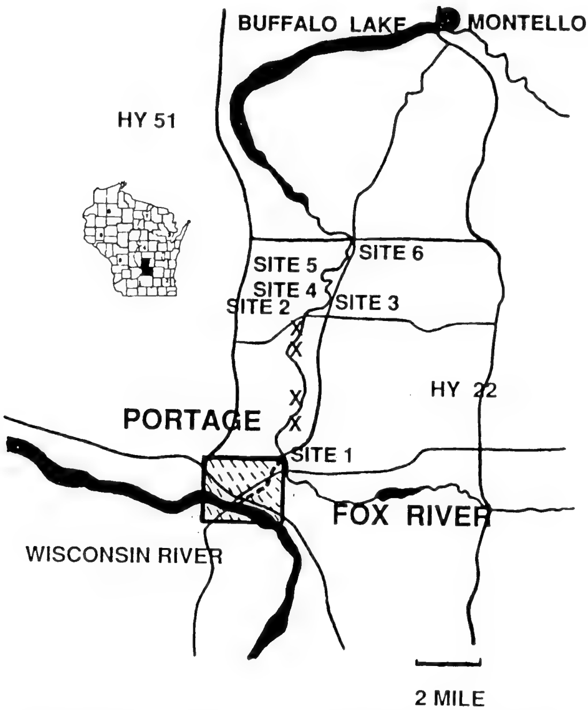

FIGURE 1. Study area, sample sites, and locations (X) of additional river birch.

The largest specimen found (254 cm circ. at site 1) was dead, fallen, and too decayed to core. Extrapolation from age/circumference data leads to an estimate of roughly 100 years for this tree indicating it began growth on the dredge banks during either the 1870s canal building or the first redredging shortly thereafter. Other large trees, 200–240 cm circumference, probably also date their germination from this era. Many of these trees were multiple-trunked, indicating probable ice damage and resprouting during their early growth years. The latter is a typical pattern for formation of multiple trunks in this species (Hepting 1971) though fire or cutting could also produce this pattern. Damage causing multiple stem growth would result in smaller trunk diameters, loss of original growth rings, and cause estimates of years since germination as determined by core-samples to be less than actual age of trees.

Trees of 125–200 cm circumference outnumbered larger trees at sites 1–3. I believe these represent first progeny of the oldest trees and probably date from periods of major channel redredging. Trees in the under 75 cm circumference classes were the most numerous at all sites except site 3. Site 3 was a section of old stream bed I believe was dredged once and then cut off from the channel by later redredging and banking. Only two sizes of tree were

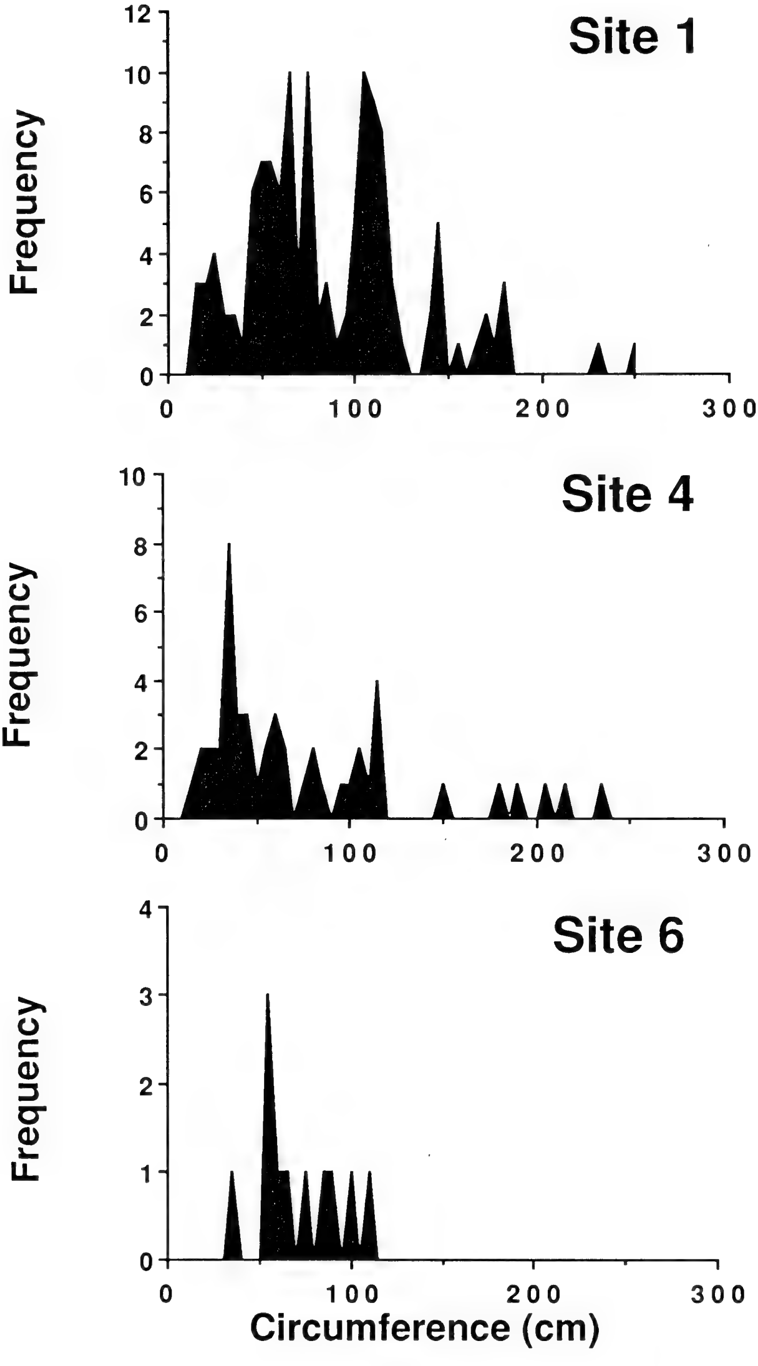

FIGURE 2. River birch size frequencies for the canal bank at Portage (site 1) and for sites 4 and 6, approximately 10 and 15 miles downstream respectively.

found at this site, 180–200 cm and 125–150 cm circumference, indicating two periods of germination and seedling establishment roughly 25 years apart. Other sites also show this approximate 25-year pattern for circumference size classes, i.e., site 1, 230–250 cm (2); 165–180 cm (7); 100–115 cm (33) with very few if any trees between these sizes. This 25-year pattern suggests that germination was greatest following the 25 year cycle of redredging of the canal. A posterori Chi square results indicated that distribution of frequency of size classes was significantly non-uniform ($P < 0.01$, $X = 213.8$, $df = 12$), indicating that trees had not germinated and/or survived at a uniform rate in all years following introduction. However, data were insufficient to significantly indicate a 25-year cycle of germination, in part due to low numbers of trees and in part due to size variation resulting from ice damage and other sources.

DISCUSSION

Little (1971) has written about the ecology and distribution of river birch in the United States, and that distribution information has been further modified by others (Coyle et al. 1983). Peattie (1950) said "seeds ripen in May and June, just when the water in rivers is high, and are borne far on the currents, until they become stranded on some muddy shore. Mud is requisite to them and they germinate in it quickly." Hepting (1971) said that river birch "is frequently injured or killed by cakes of ice carried downstream in spring thaws . . . stumps sprout prolifically."

River birch appears to require open, disturbed soil for establishment, thus explaining its presence only on dredge banks and scoured river banks in this study. I also suspect that it cannot compete with dense marsh vegetation or it would have crossed the marshes between the Fox and Wisconsin prior to canal construction. At present the northern limit to its migration into the Fox River drainage seems to be set by the marshes at the head of Buffalo Lake where disturbed sites and dredge banks are lacking. Areas of natural high banks, 2–4 meters above water level, have not been invaded and are dominated by oaks (*Quercus* sp.); low, undredged banks support largely silver maple (*Acer saccharinum L.*) or marsh vegetation.

Among river birch over 120 cm in the circumference on the lower half of the canal and dredge banks at least three-fourths are multiple-trunked specimens. This would seem to indicate high incidence of damage by ice or past redredgings. Young trees, under 80 cm circumference, on top of dredge banks show few multiple trunks and apparently are above ice damage and have not been exposed to redredging operations. Seedlings under 15 cm circumference were rare in all sites, indicating that banks have stabilized and the disturbances favoring river birch establishment have not been occurring in recent years. In fact, the tendency toward distinct age/size classes in each colony, with roughly 25-year periodicity between generations, seems to indicate that such conditions have been rare since first invasion and were largely associated with the human disturbance of

redredging the channel of the canal prior to its closure. Since 225 cm trees were present at all but the last site, it implies that the first invasion carried the species roughly 15 miles downstream; the redredging permitted extension of several more miles before reaching unsuitable habitat for colonization, i.e., absence of dredge banks and disturbance.

CONCLUSIONS

While the range extension reported for this species is not great in terms of either distance or numbers, I believe this may be the first documented study of colonization of a native riparian tree species into a new watershed as an accidental result of human activities.

Colonization was made possible by two factors: topography of the divide, similarity of river ecological conditions, and short distance between rivers; and the opportunity for invasion via canal construction.

Size and age data indicate that invasion has been episodic and stepwise rather than gradual and continuous. This is probably due to river birch having only limited ability to spread over long distances, given its special requirements for germination and establishment, and perhaps to short-term seed viability (untested).

This study serves as another reminder that human changes in the landscape may have unanticipated results in the environment. Whether river birch will advance further in the Fox River valley is uncertain, but it appears unlikely unless new major construction occurs along the river.

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AN INTERESTING HALOPHYTE SITE ON THE STRAITS AT CHEBOYGAN, MICHIGAN

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The rapid spread of halophytes, especially western ones into eastern states, is an interesting phenomenon thoroughly covered in papers published in *The Michigan Botanist* by Reznicek (1980) and Catling and McKay (1981). These papers stimulated our interest in examining possible halophyte sites in northern Michigan more closely. While collecting on August 8, 1988 on the north side of Cheboygan (location indicated by arrow on Fig. 1.), we noticed a small, much-used salt storage barn located 6 m south of Lake Street, 65 m west of Huron Street near the mouth of the Cheboygan River on the north side of Cheboygan. A brief examination convinced us that the site contained an interesting halophyte community.

Mr. Dennis Hutchinson of the Cheboygan County Road Commission informed us that this site had been used for salt storage for at least 35 years. Salt arrived here by boat both from the Detroit area and from the West through ports in Wisconsin. Salt-spreading trucks are parked here for storage. The site is also used for storage of sand, gravel, and highway rubble. Over all of the low areas there is leakage of salt, and ground near the small salt storage barn is lightly crusted even in August after summer rains.

We collected on five days at the site: 8 August 1988, 21 August 1988, 11 September 1988, 7 July 1989, and 20 August 1989. On the last four visits, we spent between one and two hours searching an area of 40 m × 90 m (.36 ha) for salt tolerant species. Taxonomy follows that of Voss (1972, 1985) for all species except *Aster brachyactis*, which follows Gleason and Cronquist (1963). All specimens have been examined by Dr. A. Reznicek and duplicate sets are deposited at MICH and MSC. The salt tolerant species found are listed below.

Agrostis stolonifera L.
Puccinellia distans (Jacq.) Parl.
Phragmites australis (Cav.) Steudel
Hordeum jubatum L.
Scirpus americanus Pers.
Juncus balticus Willd.
Juncus gerardii Lois.
Polygonum aviculare L.
Chenopodium glaucum L.
Suaeda calceoliformis (Hook.) Moq.
Atriplex prostrata DC.
Aster brachyactis S.F. Blake

All of the above species except *Agrostis stolonifera* are listed as salt tolerant by Reznicek (1980, pp. 24–25) or Catling and McKay (1981, p. 168). We have added *Agrostis stolonifera* to this list as we have observed this species in three other counties growing with *Puccinellia distans* in low, salt-encrusted depressions. Swink and Wilhelm (1979, p. 15) reported *Agrostis stolonifera* from "alkaline springy places."

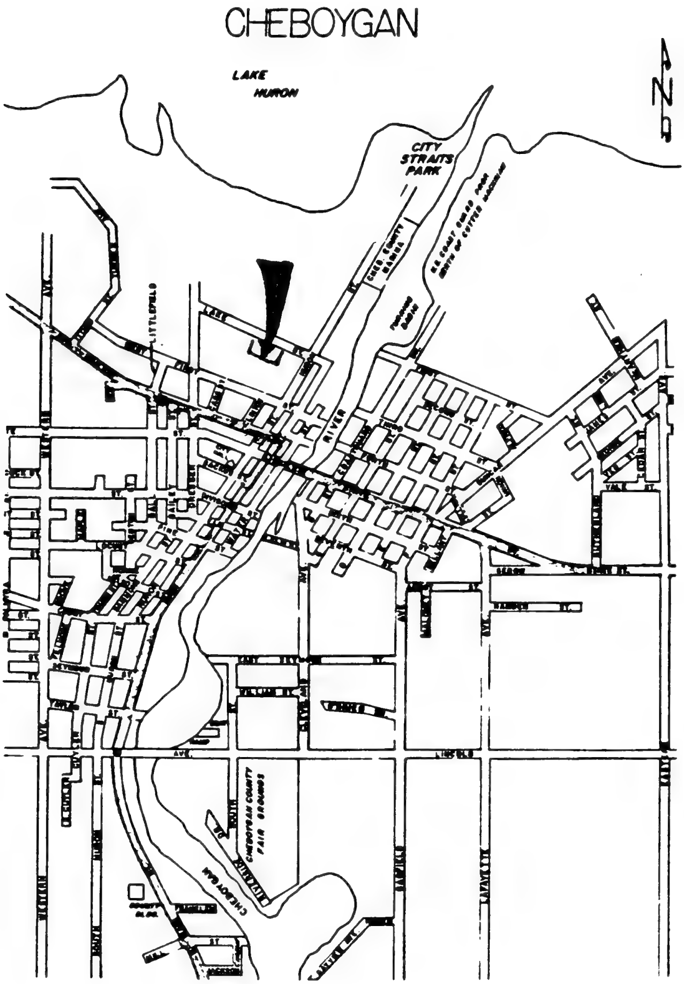

FIGURE 1. Arrow indicates location of halophyte site on north side of Cheboygan, Michigan. Map modified from Official Map of Cheboygan County, courtesy Cheboygan County Board of Commissioners.

Of the plants found here, *Puccinellia distans*, *Juncus gerardii*, *Suaeda calceoliformis*, and *Aster brachyactis* are reported for the first time from the Mackinac Straits area (Cheboygan, Emmet, and Mackinac counties). *Aster brachyactis* has previously been collected in several southern Michigan counties and also in Menominee and Schoolcraft counties in the Upper Peninsula. This is the first report of *Juncus gerardii* and *Suaeda calceoliformis* from the northern third of the Lower Peninsula. Herbaria checked for distribution information on these species were MICH, MSC, and UMBS.

All of the species listed were fairly common (fifty or more plants) at the site until July, 1989 when the west half was much disturbed by sand and gravel loading. All species listed were still present in August, 1989, but *Suaeda calceoliformis* and *Aster brachyactis* populations were reduced to a dozen or fewer plants.

Extending 30 m southwest of the salt barn, a shallow pond remains and receives salty run-off that keeps it moist into August. Here *Puccinellia distans* and *Agrostis stolonifera* line the salty banks. The low, wet basin of this pond is the only place we found *Juncus gerardii*, where it grows on elevated dirt mounds in dark, thick stands of several hundred culms. *Juncus gerardii* is rare in Michigan, being reported in Voss (1972, p. 386) from St. Clair and Wayne county collections dated 1932 and earlier. This species has since been collected at other locations north to Saginaw County.

ACKNOWLEDGMENTS

The authors thank Dr. A. A. Reznicek (MICH) for help in identification, distribution data on halophytes in Michigan, and comments on an early draft of this paper. Our thanks also to M. Penskar for helpful comments and to Drs. J. H. Beaman (MSC) and E. G. Voss (UMBS) for access to herbaria.

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ANNOUNCEMENT: THE OHIO STATE UNIVERSITY HERBARIUM 1991 PUBLIC LECTURE SERIES

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February 5. **12,000 Acres of Wonderful Wildness in Central Ohio: The Columbus Metropolitan Park System**. Gary Moore, Metropolitan Parks of Columbus and Franklin Co.

March 6. **Conservation in Tropical and Temperate Regions: Examples from Costa Rica and Chile.** Jorge Arriagada, graduate assoicate, OSU Herbarium.

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May 7. **Conservation Efforts in Ohio: An Historic View.** Ronald L. Stuckey, Curator, OSU Herbarium.

Each presentation will begin at 8:00 PM in Room 208, Botany and Zoology Building, with refreshments served afterwards in the Herbarium, Rm. 312. Parking is available in the 12th Avenue Garage, located just west of the B & Z Building. For further information, call Dr. John Furlow at 614-292-3296.

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-Implications of the Color of Forest Light
29 July—2 August:
Russ Schmitt, University of California, Santa Barbara
-Indirect Effects in Marine Communities
Sally Holbrook, University of California, Santa Barbara
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KNOTTED DODDER (CUSCUTA GLOMERATA: CONVOLVULACEAE) IN OHIO

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After 56 years, the parasitic vine, knotted dodder (*Cuscuta glomerata* Choisy, Convolvulaceae) has been rediscovered in Ohio. On August 12, 1989, I observed this species at Liberty Fen, Monroe Township, Logan County, about 1 mile west of West Liberty. The Ohio Department of Natural Resources (ODNR) owns the fen, which it acquired as a nature preserve, and once a year opens this and several other nearby prairie fens to the general public. On such an occasion, as part of the guided tour led by ODNR staff members, I observed at least 10 dodder vines growing on composites, including *Helianthus* and *Solidago*, all in one open area on wet ground near a highway. Because of their unusual appearance (Fig. 1), I obtained permission to collect a specimen, which I subsequently pressed, identified as *C. glomerata*, and donated to the Herbarium of the Cleveland Museum of Natural History (CLM).

The species was also noted that day by two other naturalists on the same tour and later that month by an ODNR staff member at another site in the same county (Cusick 1990).

The Natural Heritage Program, which inventories populations of rare plants for ODNR, designated *C. glomerata* in its 1988–89 status list as "presumed extirpated," a rating that applies to plants not documented in Ohio for 20 years or longer. Moreover, the few records obtainable indicate that the plant's presence in Ohio has always been sporadic, unpredictable, and confined to an area within a radius of 60 miles from Columbus, roughly in the center of the state.

According to ODNR data communicated to James Bissell, curator of CLM, the most recent previous specimen of *C. glomerata* was apparently a 1933 collection by C. J. Willard in Madison County, west of Columbus, with no location data supplied. Before that, a 1920 specimen was collected by Mrs. Bryan Taylor, also in Madison County, "southwest of South Jefferson." The Ohio State University Herbarium in Columbus now preserves both specimens. Apparently the 1989 specimen is the first record from Logan County, which lies about 50 miles northwest of the 1920 site.

Earlier Ohio records are equally sketchy. Cooperrider (1982) mentioned a specimen from Pickaway County, southeast of Madison County and directly south of Columbus. Kellerman and Werner (1893) listed a specimen from Licking County, directly east of Columbus; this specimen may prove to be the farthest east the species has traveled not only in Ohio

FIGURE 1. The parasitic plant, knotted dodder (*Cuscuta glomerata*) climbing up the stem of its host-plant (*Helianthus* sp.) in Liberty Fen, August 12, 1989. The dull yellowish color of the flowers and the ropelike inflorescence makes this plant one of the most distinctive taxa within the North American *Cuscutas*.

but in its entire range. All sites except the Licking County station suggest a plant infrequently found in the so-called Prairie Peninsula of central Ohio, a flat, well-watered, tall-grass prairie of rich soils, now largely claimed by agriculture.

As in the case of many native Ohio plants associated with prairie habitats, Ohio locations of *C. glomerata* occupy the extreme eastern por-

tion of a huge midcontinental range, in this instance, southwest Michigan west to South Dakota and south to Mississippi and Texas (Fernald 1950). The center of abundance, as depicted on the map in the *Atlas of the Flora of the Great Plains* (Great Plains Flora Association, 1977) lies in the eastern half of Kansas, where nearly every county is represented. Most of the stations in the Great Plains states are found west of the Missouri River, with scattered locations in Iowa, Minnesota, and Missouri between the Missouri and Mississippi Rivers. East of the Mississippi, observers have found *C. glomerata* in a few scattered stations in Indiana, Illinois, Wisconsin, and Michigan (Steyermark 1963; Mohlenbrock 1975; MacMillan 1892; Deam 1940; Stevens 1948).

OHIO. LOGAN CO.: Monroe Township, 1 mile W of West Liberty, within Liberty Fen. One large colony, parasitizing composites. 12 August 1989, *Peskin s.n.* (CLM).

ACKNOWLEDGMENTS

The author wishes to thank Dr. Tom S. Cooperrider for generously supplying a list of references and Dr. A. A. Reznicek for determining the specimen.

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REVIEWS

A CHECKLIST OF THE FLORA OF ONTARIO: VASCULAR PLANTS. By J. K. Morton & Joan M. Venn. University of Waterloo Biology Series No. 34. Department of Biology, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1. 1990. x + 218 pp. Cdn. $20 + $2 postage and handling.

As its title indicates, this is a list of the vascular plants known to occur or to have occurred in the noncultivated flora of Ontario. It is not an identification guide; there are no keys, descriptions, illustrations, or notes on distribution in the province. Within the pteridophytes, gymnosperms, monocots, and dicots, respectively, the families are listed in alphabetical order, and the genera and species alphabetically within each family. Cross-referencing is provided for basionyms and virtually all synonyms likely to be encountered in recent literature.

This list represents extensive field work by its authors, whose previous publications include floristic lists for the Manitoulin and Tobermory islands of Lake Huron. It also represents a great deal of research in herbaria and an obviously exhaustive survey of the literature on plant distribution.

Numerous species are listed that were not known to occur in Ontario when Scoggan's *Flora of Canada* was written, among them some not even mentioned in *Gray's Manual*, indicating how rapidly the flora of Ontario (like that of other parts of North America) is changing. Most of the newly listed species are naturalized, some newly established on this continent, others long known south of Lake Erie and evidently extending their ranges northward. The list also indicates, however, that additional native species have been discovered in Ontario as recently as the 1980s, suggesting that at least a few more remain to be found.

Some species attributed to Ontario in earlier works are not accepted here as being part of the provincial flora. The authors have done a thorough job tracking down the origins of questionable reports and ascertaining the documentation of rare species. References are cited for many of the rejected records, but the undoubted economies affected by the limited citation of literature and the absence of specimen citations may be considered an unfortunate tradeoff by those who wish to determine the basis for the inclusion of a species or for the rejection of a report. Taxa below the rank of subspecies are not covered, and consequently some well-marked varieties—such as *Ranunculus hispidus* var. *hispidus* and var. *caricetorum*, which I prefer to recognize as separate species—are not distinguished in this list.

Both the classification and the nomenclature represent a remarkably comprehensive review of the pertinent literature. Although every effort has obviously been made to present modern classifications and up-to-date nomenclature, the authors have been prudent in accepting only those revisions that are consistent with "mainstream" taxonomic thought and practices, eschewing extremes of "splitting" and "lumping." Any individual taxonomist is likely to find a few groups "split" too much for his or her liking,

perhaps in the Caryophyllaceae, where generic delimitation is persistently controversial, and others "lumped" more than he or she would have preferred. Most taxonomists, however, will be pleased with the treatments followed most of the time. All concerned with the production of this list are to be commended for minimizing the publication time.

Because of the authors' thorough searches of both literature and herbaria, this list can—for a while—confidently be used to determine whether or not a species has hitherto been known to occur in Ontario's spontaneous flora. In addition, Ontario botanists and amateur naturalists now have a new reference that can be used as a standard source of botanical names. I am always irked to see new publications in which "Nomenclature [meaning classification as well] follows Gray's Manual, ed. 8 (Fernald 1950)." In what other branch of the sciences is it a common practice to dismiss as inconsequential everything that has resulted from studies during the past 40 years? This modern list should be considered an appropriate replacement as a source of botanical names for anyone working with Ontario plants.

Unfortunately, this otherwise excellent work is marred by the inclusion of a vituperative editorial, contending that much taxonomic revision is motivated by the taxonomists' desire to see their names attached to new nomenclatural combinations rather than by a genuine desire to improve plant classification. However much the authors may feel that this controversial opinion—which I consider grossly unjustified—needs to be expressed, it does not belong in a publication that should be a long-term standard reference. Such statements will tend to alienate amateurs from professional botanists and will discourage the support of research in systematics. It is to be hoped that a second printing or edition will appear without this editorial comment.

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FIELD GUIDE TO THE PEAT MOSSES OF BOREAL NORTH AMERICA. By Cyrus B. McQueen. University Press of New England, Hanover, NH, 03755. 1990. 138 pp. 28 color photographs. $22.95 (paper).

A generation ago, when I had a tough time putting names on my own collections of *Sphagnum*, I got help and encouragement from A. LeRoy Andrews and Hugo L. Blomquist, the only two persons in North America who knew any peatmosses at all. A good number of bryologists now recognize species by their microscopic characters and also by their "look," in the wetness of nature and in a dry condition. Most of the species are distinctive in aspect and in ecological setting, yet some can be decided on only by microscopic examination. Some belong to species complexes, and it becomes an exercise in small-mindedness to bother with such piddly intergrades at all. However, I often sort out trivialities from the confusion centered around *Sphagnum recurvum*, *S. subsecundum*, and *S. capillifo-*

lium in the hope that their small differences will some day make sense. It amuses me now that I began by calling the red ones *S. rubellum* because the name seemed suitable. I now know a number of red species but still do not know what *S. rubellum* is or if it deserves naming. When I really see *S. russowii*, I usually know it, but I often misapply the name in the field. Some specimens of *S. tenerum* I name by geography, some by flipping a coin. I refuse to bother with *S. subtile*—in the woods it is *S. subtile*, in the open *S. capillifolium*. I keep reminding myself that a litter of cats is vastly more diversified than we allow a species of *Sphagnum* to be.

In spite of this crotchety attitude, I show my students that *Sphagnum* can be used with considerable success in ecological studies, and the species, or at least many of them, with their many similarities and differences, however subtle, can usually be recognized just as easily as people can be. A reviewer of my *Peatlands and Peat Mosses*, said the keys were not "user friendly." I had not expected them to be, nor would I wish to change them. Many species are, in fact, unfriendly. Recognizing such species by gross morphology is just not possible.

Now here is a guide for field identification that gives not a word of information on microscopic features. It includes a series of color photographs, most of them very good, and it presents random access and dichotomous keys to 27 species of broad range, as well as a more extended dichotomous key to about twice that number, actually to nearly all the species known from North America. The author reports that undergraduate students can use the keys, but I have had only spotty success with them. However, the descriptions and illustrations, especially the photographs, help. The criticisms that I might make are the merest quibbles. The author knows the plants, and his field knowledge and enthusiasm show through. He has produced an attractive introduction to these plants and should not be blamed for their cussedness. I see this book as a starter, to be followed in use by more technical and more informative works. I might point out, in all modesty, that the photographs and line drawings in my own *Peatlands* provide a step up in understanding.

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A NATURAL HYBRID OF GRAY DOGWOOD, CORNUS RACEMOSA, AND ROUND-LEAVED DOGWOOD, C. RUGOSA, FROM MICHIGAN

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Despite much effort by a number of authors, we are regrettably still not agreed on the taxonomic status of some of our eastern North American dogwoods. Whether the silky dogwood, *Cornus obliqua* Raf., is conspecific with "red-willow," *C. amomum* Miller is still a question (Wilson 1965, Voss 1985). Both taxa, whatever their status, occur in Michigan. Whether the stiff dogwood, *C. foemina* Miller is conspecific with gray dogwood, *C. racemosa* Lam. is likewise a question. Only taxon *racemosa* is known from Michigan. There is even doubt about the red osier, *C. stolonifera* Michaux; it may belong to the same species as the European *C. alba* L. (Fernald 1950, Voss 1985).

The picture in the bractless shrubby dogwoods is further confused by the formation of interspecific hybrids. Some of these, e.g. *C. amomum* × *racemosa* (*C.* ×*arnoldiana* Rehder) are fairly frequent in the lower peninsula of Michigan, but various hybrids involving *C. drummondii* C. A. Meyer are found only in southeastern Michigan, where this species becomes locally common in association with both *C. racemosa* and *C. amomum*. Hybrids involving round-leaved dogwood, *C. rugosa* Lam., are unreported from Michigan, but its hybrid with *C. stolonifera*, known as *C.* ×*slavinii* Rehder, has been reported both east and west of Michigan, from New York to Wisconsin. Herein I describe what is apparently a very distinctive new hybrid taxon, *C. racemosa* × *rugosa*, detected first as a small group of plants in Minnesota by Thomas A. Friedlander, and later by me in southern Michigan as a large and healthy clone.

Cornus ×friedlanderi W. H. Wagner, *nothosp. nov.* (Fig. 1)—TYPE: Michigan, Washtenaw Co., Lyndon Twp. Sec. 28, on wooded slope near *Cornus racemosa* and C. *rugosa*, 28 May 1977, *W. Wagner 77102* (holotype: MICH).

Frutex clonalis usque ad 3 m altus, inter *C. racemosam* et *C. rugosam* intermedius. Rami rubelli, nitidi, et laeves solum in 10–30 cm distalibus, alibi impoliti cinerascentes scabri. Gemmae terminales 5–7 mm longae. Foliorum laminae ovato-lanceolatae, 10 (8–11.5) × 4.5 (3–6) cm, nervis lateralibus principalibus utrinque 6 (4–7). Laminae pili 0.3–0.9 mm longi, appressi vel erecti, recti vel curvati. Fructus ut videtur abortivi.

Clonal shrub to 3 m tall; intermediate between *C. racemosa* and *C.*

FIGURE 1. Flowering twigs of dogwoods. Upper left: *Cornus rugosa*. Upper right: *C. racemosa*. Lower: *C.* ×*friedlanderi*. Size bar = 15 cm.

rugosa, stems reddish, shiny and smooth only in apical 10–30 cm, dull grayish and rough elsewhere; terminal buds 5–7 mm long; leaf blades ovate-lanceolate, 10 (8–11.5) × 4.5 (3–6) cm, with 6 (4–7) major lateral veins per side; laminar hairs 0.3–0.9 mm long, appressed to raised, straight to curved; fruits apparently abortive.

Named for Thomas A. Friedlander, who first recognized this hybrid and is an outstanding teacher of biology. A detailed description of the new nothospecies compared with its parents is given in Table 1.

The colony of *C.* ×*friedlanderi* has been observed now over a period of 20 years, but whenever it flowered, very few fruits were formed. The colony, without question a large single clone, extends over an area of approximately 6 × 6 m. There are some large individuals, up to 3 m tall, three with main vertical stems 2–3 cm and three 1–2 cm in diameter. There are also approximately 20 additional small individuals, with main stems 0.2–0.8 cm thick. On the wooded slope below the colony and coming in contact with it is a huge dense colony of *C. rugosa*. On the slope above the hybrid but not in contact with it are clones of *C. racemosa*.

Prominent woody plants occurring on this slope are *Amelanchier arborea* (Michaux f.)Fern. *Carya glabra* (Miller)Sweet, *Juniperus communis* L., *J. virginiana* L., *Prunus serotina* Ehrh., *P. virginiana* L., *Ribes cynosbati* L., *Rubus idaeus* L., *Quercus alba* L., *Q. rubra* L., *Viburnum acerifolium* L., and *Vitis riparia* Michaux. The last was found growing over the tops of a couple of the large individuals of the hybrid dogwood. In February 1990, there were several inches of snow in the woods, but we could recognize protruding above the snow surface dried fruiting specimens of members of the following herbaceous genera: *Anemone*, *Desmodium*, *Geum*, *Leonurus*, *Osmorhiza*, *Phryma*, and *Solidago*. In September 1990, we observed in addition plants of *Circaea*, *Galium*, *Hepatica*, *Phryma*, *Polygonatum*, *Sanicula*, *Solanum*, and *Solidago*. We noted that all of them except *Leonurus cardiaca* L., are familiar native plants of oak-hickory forest.

The only dogwood that could readily be confused with this new nothospecies is probably *C. amomum*. The leaves, including size, shape, and veins, are rather similar. The latter differs, however, in the stems that are reddish and smooth for a much longer distance from the apex. When the surface becomes rough, it produces a spotted or mottled alternation of light brown corky lenticels and a smooth reddish periderm. The terminal internodes of the twigs of *C. amomum* possess a dense covering of whitish appressed hairs. The inflorescence of *C. amomum* is somewhat flatter than that of *C.* ×*friedlanderi*.

Nearly all of the characters of the hybrid are intermediate between the parents, as shown in Table 1. The most striking differences between the parents are the distances between the secondary branches (which in *C. rugosa* is approximately twice that in *C. racemosa*, Fig. 2), the amount of smooth periderm (indefinitely extensive in *C. rugosa* to very limited in *C. racemosa*), terminal bud length (long vs. short), leaf blade (size, shape, and lateral vein number; Fig. 3), and the trichomes of the abaxial leaf surface

TABLE 1. Comparison of some characters of two dogwood species and their hybrid based on adjacent clones in the same habitat.

	C. racemosa	*C. ×friedlanderi*	*C. rugosa*
Diameter primary stem 25 cm from tip	2.4 (2-3.5) mm	3.1 (3.0-3.5) mm	3.2 (3-4) mm
The same, 50 cm from tip	3.5 (3.2-4.0) mm	5.2 (4.3-5.5) mm	4.6 (4.0-5.5) mm
Diameter secondary stem within 25 cm from primary tip	1.2 (1.1-1.5) cm	2.1 (1.5-3.0) cm	2.2 (1.8-2.5) cm
Maximum distance between nodes within 25 cm from primary tip	6.3 (4.5-10.0) cm	8.9 (8.5-11.0) cm	11.7 (8.0-15.0) cm
Longest extent of smooth or partially smooth epidermis from step tip	9.9 (5.5-20.0) cm	23.0 (17-30) cm	Continuous
Periderm surface	Smooth, gray, "powdery", finely ridged	Rough, gray, coarsely and irregularly ridged	Smooth, no surface cork except at lenticels
Lenticels	Punctate, nearly circular, less than 0.1 mm in diameter	Round to elongate, variable, up to 1.5 mm long	Round to elliptic, halo around each
Terminal bud length	3.1 (2.5-4.5) mm	5.8 (5.0-7.0) mm	6.3 (4.5-8.0) mm
Leaf blade length	4.4 (3.7-5.2) cm	9.7 (8.1-11.4) cm	8.9 (8.4-9.7) cm
Leaf blade width	1.8 (1.3-2.5) cm	4.5 (2.8-5.7) cm	6.2 (4.2-7.4) cm
Average ratio W/L	0.41	0.46	0.69
Petiole length	7.3 (5-10) mm	12 (11-14) mm	17 (15-21) mm
Major vein number per side	3.6 (3-4)	6.1 (5-7)	7.8 (7-8)
Trichomes			
a. length on abaxial blade surface	0.2-0.4 mm	0.3-0.9 mm	0.3-1.2 mm
b. Orientation	Appressed	Appressed to raised	Raised
c. Shape	Straight	Straight to curved	Curved to twisted
d. Direction	Parallel to midrib	Irregular	Pointing in various directions
e. Abundance	Sparse and remote	More numerous and closer	Abundant and overlapping
Inflorescence	Pyramidal	Convex but slightly more raised in middle	Convex
Anthesis (June)	Second week	First week	First week
Leaf flushing (1 May 1990)	Full sized	Nearly full sized	1/3-1/2 full size
Color change (4 Oct 1990)	Still green	Green and yellow	Yellow and brown
Leaf fall (20 Oct 1990)	Lvs. still attached practically all green (a few yellow)	ca. 2/3 fallen, remaining lvs. yellow to brown	Lvs. all fallen

FIGURE 2. Winter twigs of dogwoods. Left: *Cornus rugosa*. Middle: *C.* ×*friedlanderi*. Right: *C. racemosa*. Size bar = 15 cm.

(number, appression, shape, and abundance). The noted "scratchy" surface of *C. rugosa* leaves is absent in *C. racemosa* and only somewhat developed in the intermediate (Fig. 4). The leaves of *C. rugosa* appear later and drop earlier than those of *C. racemosa*; *C.* ×*friedlanderi* has an intermediate leaf duration.

The single presently known colony of *C.* ×*friedlanderi* should be preserved in its natural state for several reasons, among them the following: the occurrence is a fine example of natural hybridization in woody plants. Further studies of it may be carried out in the future, including morphometrics, cytogenetics, allozyme electrophoresis, and comparative molecular biology. The plant may be distinctive and interesting enough to horticulturists and arborists to suggest that careful propagation of cuttings from time to time may lead to a successful cultivar. Accordingly I recommend that it should be protected from destruction of its habitat and from vandalism.

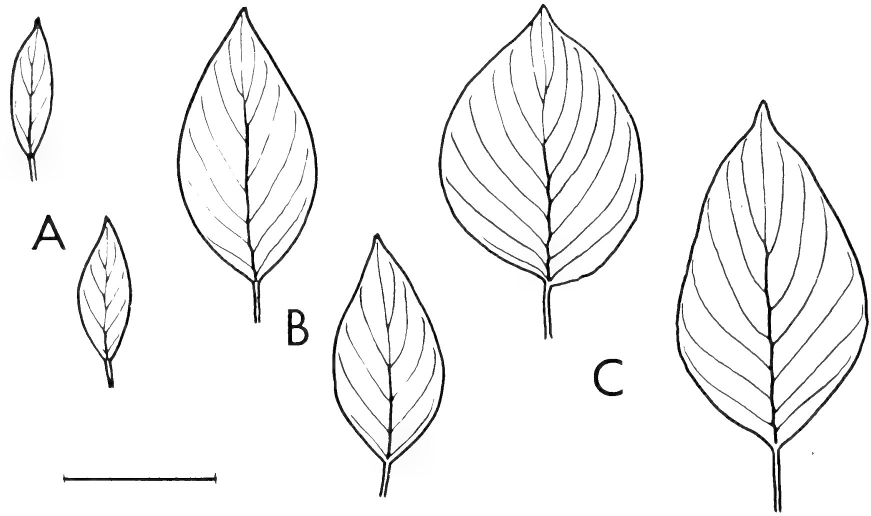

FIGURE 3. Major veins of dogwoods. A. *C. rugosa.* B. *C. ×friedlanderi.* C. *C. racemosa.* Size bar = 5 cm.

ACKNOWLEDGMENTS

I acknowledge the aid of W. R. Anderson, Robert I. Masta, Steven Kobylarz, and particularly Thomas A. Friedlander, whose original discovery inspired the work presented here. The photographs were taken by David J. Bay.

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FIGURE 4. Abaxial blade hairs (photographs of dried specimens). Top: *Cornus rugosa*. Middle: *C.* × *friedlanderi*. Bottom: *C. racemosa*.

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REVIEWS

A FOCUS ON PEATLANDS AND PEAT MOSSES. By Howard A. Crum, in collaboration with Sandra Planisek. University of Michigan Press, 839 Greene St., P.O. Box 1104, Ann Arbor, MI 48106. 1988. vii + 306 pp. $50.00, hardbound.

This is an extremely valuable and welcome book, filling a long-standing void. Larsen's *Ecology of the Northern Lowland Bogs and Conifer Forests* is disappointing in many respects; Moore and Bellamy's *Peatlands* concentrates on European plants and sites and is not always very readable. Dr. Crum's new book is comprehensive, coherent, and focussed on Great Lakes peatlands (though largely applicable elsewhere in the northeastern U.S. and adjacent Canada), and it will be useful to wetland evaluators and managers as well as academic researchers.

The many interactions and feedbacks among peatland vegetation and physical/chemical factors make it impossible to treat peatland ecology in any simple, linear fashion. Professor Crum targets a different aspect of the subject in each chapter, but the themes of acidity, wetness, nutrients, and the flora appear again and again in an almost fugal fashion. Thus the book is best read as a whole.

Chapter 1 presents basic definitions of the four wetland types: marshes (not *peat*lands, and thus not further discussed), swamps, fens, and bogs; descriptions of peatland types around the world are also presented. These are followed by an excellent comparison of several schemes of peatland classification. Those not very familiar with peatlands may find this more meaningful after reading the rest of the book.

Chapter 2 explains the development of peatlands through lake-fill and paludification, clarifying the separateness of the poor fen to bog succession and the rich fen to swamp succession, and debunking the myth that either one can develop into upland forest. Here is a refreshingly clear-headed, common-sense, natural-history approach to understanding peatland development that should be of great value to those engaged in site evaluation and management.

Chapter 3 covers peatland floristics, including commonness/rarity of various species, their value as indicators, and zonation especially in bogs. One of the best things about this treatment is (as you might expect from this author) the inclusion of many species of bryophytes. The summary list of peatland species on pp. 65–70, while not exhaustive, could serve as a standardized general checklist for, e.g., land planners trying to decide whether or not a site *is* a peatland.

Chapter 4 discusses nutrient relations and the effects of pH on nutrient availability. Having spent many hours digging through the often extremely technical literature on this topic, I appreciate having a handy guide to the roles and dynamics of all the major plant nutrients in one place.

Chapter 5 is an equally handy account of the essentials of peatland hydrology and water relations, plus some other environmental factors or processes such as temperature, acid rain, and the effects of *Sphagnum* on its

environment. Neither of these chapters is extremely quantitative; they give instead a good explanation of the processes and principles involved.

The next two chapters focus on the uses of peat and peatlands. Chapter 6 discusses the fossil record in peatlands, especially the use of pollen analysis to reconstruct past vegetation, and includes a brief summary of the postglacial vegetational history of the Great Lakes region. Chapter 7 compares classifications of peat types (as opposed to peat*land* types) and methods of peat mining, and discusses peat cropping, including information ranging from biotic principles controlling nutrient availability to detailed practical information on planting. The chapter also contains an entertaining catalog of folk uses of *Sphagnum*, and concludes with some comments on peatland conservation and "reclamation", noting that mined peatlands will never return to their original state.

The final chapter is a unique feature of this book, and may be its most valuable feature for many readers. "A Bryologist's Vademecum" explains the structure and life history of peat mosses, gives helpful hints on studying them, recommends other useful literature, and provides a key to the sections and Great Lakes region's species of *Sphagnum*. The species descriptions include not just ecological characters and habitat requirements but also field identification hints—the "tricks of the trade" often not given in keys. For those not lucky enough to spend time in the field with Dr. Crum, this is the next best thing. The many drawings and photos of the species are also extremely helpful. It is to be hoped that this chapter will encourage more botanists to learn to identify species of *Sphagnum*, a skill that is not nearly as difficult as is often believed.

The book concludes with a helpful Glossary, an extensive Bibliography, and a complete Index.

One of the most attractive features of the book is the large number of illustrations, both line drawings and black-and-white photographs. It would have been ideal to have had color photos of the *Sphagnum* species, as color is such a good field character, but this would no doubt have been prohibitively expensive. The captions for the drawings of vascular plants in Chapter 3 vary from extremely informative to nearly nonexistent (species name only). Figures 1–33 and 1–34 are transposed, and Figure 2–6 is left/right reversed (or the caption should say "left" where it now says "right").

Not every peatland ecologist will agree with all of Dr. Crum's interpretations. For example, I am not convinced that rich fens necessarily develop into cedar swamps, or that all cedar swamps came from rich fens (Chapter 2). I heartily agree, however, that neither one is related to bog succession, and am glad to see this distinction so clearly made. In Chapter 2 especially, but also elsewhere, one might wish for more frequent citations of sources and a clearer delineation of where literature review ends and the author's personal observations and interpretation begin (although too extreme an application of this can lead to a text so littered with citations as to be unreadable; a happy medium is difficult to achieve).

Professor Crum's elegant and inimitable style makes the book a joy to read, with descriptions of liverworts that "have a furtive existence in dark,

wet holes" (p. 62), or a species of *Sphagnum* with "the sodden appearance of wet cat fur" (p. 231). Each chapter and major section also begins with some apt quotation, often from Thoreau. No sources are given for any of these quotes, however, which I found frustrating. Finally, I cannot resist pointing out a minor matter of orthographics that irritated me throughout the book—the use of *dryer* rather than *drier*. According to the American Heritage Dictionary, the latter is the comparative form of *dry*, while the former is a noun denoting a household appliance.

With the increased awareness, especially in the last two decades, of the importance of wetlands in the landscape, many people have felt the need for a book covering all aspects of peat and peatlands. This book fulfills that need, and does so wonderfully.

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FLOWERING PLANTS NIGHTSHADES TO MISTLETOE. The Illustrated Flora of Illinois. By Robert H. Mohlenbrock. Southern Illinois University Press, Carbondale. 1989 ["1990"]. 224 pp. $40.00

This is the 12th volume of its series to deal with vascular plants of Illinois, presenting keys, descriptions, illustrations, and Illinois distribution maps. The current volume covers 100 species and hybrids in the orders Solanales, Campanulales, and Santalales (including Celastraceae). Having dealt very recently with the first of these orders for the final volume of *Michigan Flora*, I know how tricky the taxa can be, and shudder that in Illinois over twice as many species of *Physalis* are recognized than in Michigan.

Physalis ixocarpa should be called *P. philadelphica* Lam. (see Ann. Missouri Bot. Gard. 60: 668–669. 1973). Following *Flora Europaea*, the author takes up *Solanum cornutum* for *S. rostratum*, although that synonymy was later shown to be erroneous (see Gentes Herb. 11: 397–406. 1979; Lejeunia 101: 45. 1980). *Solanum ptychanthum* is consistently misspelled *S. ptycanthum*, following some recent authors but ignoring Dunal's original and philologically correct spelling. *Datura inoxia* is also misspelled. The plant described and illustrated as *Solanum sarrachoides* does indeed appear to be that species and not *S. physalifolium* Rusby, which has usually been misidentified as *S. sarrachoides* and which we have in Michigan (see J. Linn. Soc., Bot. 92: 1–38. 1986).

For some reason Yuncker's 1932 treatment of *Cuscuta* is cited rather than his later one (N. Am. Fl. II(4). 1965). Contrary to most recent authors, *Campanula uliginosa* is separated from *C. aparinoides*; in fact, the key makes the distinction appear much easier than it really is. But in general, the taxonomy of this volume makes sense. The author follows Piehl in including *Comandra richardsiana* in the synonymy of *C. umbellata*, yet declares that *C. richardsiana* parasitizes the roots of several different kinds of trees. Is that intended to imply a distinction in host plants from *C. umbellata* sens.

lat., which according to Piehl parasitizes over 200 hosts in the Great Lakes region alone, many of them herbaceous?

The publisher persists in placing the abbreviated name of Linnaeus in a different type face than for all other authors of generic names—with one exception: after the generic name *Campanula* (p. 156) it is correct. It is a pleasure to see that the names of higher taxa are now consistently (and correctly) treated as plural.

This volume should prove useful in areas adjacent to Illinois, especially since it seems to include more species and may help with puzzling unknowns and stray species.

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ANNOUNCEMENT: ANN ARBOR FLOWER AND GARDEN SHOW

The University of Michigan's Matthaei Botanical Gardens is pleased to announce the 1991 Ann Arbor Flower and Garden Show. It will be held on Thursday, April 11 through Sunday, April 14 at the University's Yost Ice Arena.

The theme of this year's Show is "A Gardener's Holiday." International travel, seasonal celebrations, and festivals will be expressed in the design and horticultural class exhibits. Plant societies will showcase some of the plants they cultivate and/or study; the Michigan Botanical Club will be exhibiting selected ferns native to Michigan. Landscape contractors and nurserymen will create varied and striking garden designs. A wide variety of gardening items will be available for purchase in the Marketplace.

Admission to the Show is $8 for adults, $6 for children who are twelve and under. Advance tickets are highly recommended since they guarantee immediate entry at the date and time specified on the ticket. Tickets are available at the Michigan Union Ticket Office, all Ticketmaster outlets, and Hudson's Department Stores.

For more information, please contact:
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EDITOR'S REPORT—A REQUEST FOR ASSISTANCE

We are certain that you have noticed that the last several issues of *THE BOTANIST* have not arrived during (or near) the month printed on the front cover. We thought that you might be interested in both an explanation of some recent problems and what our present situation bodes for the future.

The October issue is late for a simple reason. It was delayed until there were enough papers on hand that were ready to publish! As a corrected manuscript was received, it was marked and added to the pile that eventually became the issue now in your hands. As of this writing (1 December), there are **0** (that's right, zero) manuscripts on hand and ready for the January issue. How did we get to this point?

Several issues have conspired in this situation. As of 1 December, the manuscripts that we are handling can be summarized as follows:

Manuscripts submitted since 1 January 1990: 18
Manuscripts now in review: 9
  Manuscripts waiting for an overdue review (over 6 months): 3
Manuscripts accepted, returned to the authors for corrections: 20
  Manuscripts returned over 6 months ago: 3
  Manuscripts returned over 1 year ago: 6
Book reviews assigned over 1 year ago: 8

While manuscript submission appears healthy (thanks to all authors!), we have run into a serious problem once the manuscript goes out for review and then back to the author for corrections. Both Gary and I are editing *THE BOTANIST* in addition to our other duties, not leaving us much time to spend on calling/writing to discover the whereabouts of a review, manuscript, etc. The flip side of the coin is that the reviewers provide their service *gratis* to *THE BOTANIST*, so we can get caught between an anxious author and a procrastinating reviewer. What we would like to ask is cooperation from our reviewers. We value their opinions and appreciate their efforts, but we don't have the resources to repeatedly request delinquent reviews.

The problem that is more puzzling to us involves papers that are accepted and sent back to the authors to respond to the reviewers comments and make appropriate corrections. While there may be an occasional set of circumstances that warrant long delays before a return, this seems to have become a major problem. These papers include data that should see "the light of day" and would be of interest to our readers. Papers that return over a year from initial acceptance must be reviewed again, adding yet another step in the process.

Did you notice the number of book reviews in this issue? There are two reasons for them. One, they arrived and provided copy for the issue. Two, they are an important facet of the journal since they provide you with information about the current literature. As noted above, we have eight books out in the hands of reviewers and are still waiting for their reply. Please keep the reviews coming in!

This is also a good time to respond to an often-heard comment about *THE BOTANIST*. Why aren't there any nature education articles? We repeat the same answer that we have used for the last year: THERE ARE NONE SUBMITTED FOR CONSIDERATION. Just as with any publication, we cannot publish what we don't have and we don't have the resources to solicit manuscripts. We will gladly consider submissions!

—Richard K. Rabeler & Gary L. Hannan

✓ EDITORIAL NOTICES

NOTICE TO CONTRIBUTORS

In the face of economic necessity, we find it necessary to modify the page charge assessment policy of THE MICHIGAN BOTANIST. After comparison of our policies with those of other comparable journals as well as discussions among the Co-Editors and members of the Editorial Board, the following policy will be implemented effective with the next issue, Volume 30, No. 1 (January, 1991).

PAGE CHARGES

Members of the Michigan Botanical Club and **subscribers** to *THE MICHIGAN BOTANIST*: 8 free pages per calendar year, $35.00 per page for any additional pages.

Non-members and **non-subscribers**: $35.00 per each page.

Any manuscripts subject to page charges (all non-member/subscribers and those of members exceeding their allotment) should be accompanied by a statement acknowledging this policy and ability to pay the assessed charges. Subsidy of the entire cost of the article is expected when it includes an acknowledgment of grant support.

—The Co-Editors and
The Editorial Board

A NOTE OF THANKS

We would like to take this opportunity to express our thanks to Dr. Tony Reznicek for the time and effort that he expended in serving as business and circulation manager for *THE MICHIGAN BOTANIST* during the past 12 years. We deeply appreciate the guidance that he provided on financial matters, allowing us to concentrate on editing while knowing that the journal was on a sound financial footing.

On behalf of the Editorial Board, the Michigan Botanical Club, and our readers, thanks for all that you did for *THE MICHIGAN BOTANIST.*

AN INTRODUCTION

While we will miss Tony, we are pleased to announce that a capable successor has been found. Effective 1 January 1991, Dr. David C. Michener has assumed the role of business manager. David is the taxonomist at the University of Michigan's Matthaei Botanical Gardens, coming to Ann Arbor from the Arnold Arboretum in January of 1990.

—Gary L. Hannan
Richard K. Rabeler

The May issue (Vol. 29, no. 3) was mailed November 27, 1990.

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On the cover: *American columbo* (Swertia americana), *at the Gourdneck State Game Area, Kalamazoo Co., Michigan.*
Photographed by Richard Pippen, July 1978.